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Thermic Syphons for Locomotive Fireboxes

It is a well-known fact that firebox heating surface is much more productive as a steam generating medium than any other part of the boiler, and some attempts have been made to increase the firebox heating surface by using a horizontal water leg in place of a brick arch. This method did not prove successful, due to the fact that it provided in effect a cold blanket over the fuel bed which hindered rather than aided the complete combustion of the gases, the purpose for which an arch is used. The most recent development along this line is that of the thermic syphons, which are described elsewhere in this issue. They consist of two triangular water legs extending down from the crown sheet to the throat. The fire bricks are supported on the long side of these water legs and the syphons form in effect three combustion chambers above the arch. Thus, the additional heating surface is located in the hottest part of the firebox and divides the flame into three sections, thus increasing its total radiating surface. With these water legs placed above the arch the combustion of the gases should be far enough along to prevent the formation of soot and smoke. This is further checked by the incandescent arch which forms one side of each of the three chambers. A much larger amount of radiant heat should thus be absorbed from the burning fuel than has hitherto been possible and as the amount of heat obtained by radiation is far greater than that obtained by the contact of the hot gases with the heating surfaces, a greater amount of heat from the fuel is utilized. The circulation through these syphons being exceedingly brisk a large amount of heat should be absorbed. This not only increases the evaporating efficiency of the firebox, but affects the entire boiler, as better circulation throughout the boiler should be obtained. The first installation of thermic syphons was made on the Chicago, Milwaukee & St. Paul about six months ago and the tests, which are reported on another page, show that a marked increase in evaporative efficiency was obtained.

Fundamentals in Autogenous Welding

The development of both oxy-acetylene and electric methods of welding metals has been rapid during the past few years. In many cases all that was deemed necessary was to place the apparatus in the operator's hands and after a perfunctory course of instruction set him to work with the thought that welding troubles were over. Many roads soon found, however, that there is much to learn in the handling of the apparatus if successful results are to be obtained. Some roads have developed far more rapidly than others and are doing work which has been impossible on other roads. The chief reason for this is that they have given the problem very careful study and have sought to get down to fundamentals. They soon found that in order to get good work and to weld difficult jobs that thorough instruction was necessary and this cannot be over-emphasized, for the possibilities for saving money by these methods of welding are great if they are handled properly.

There appears elsewhere in this issue an article discussing some fundamental facts regarding the oxy-acetylene process, in which it is shown that there are right and wrong methods of handling the torch. Of particular interest is the analysis of the oxy-acetylene flame and how easy it is by the improper manipulation of the flame to make a soldering rather than a welding job; also, how important it is that filler materials of proper characteristics should be used in order to obtain satisfactory work. It is these things that must be carefully studied in the handling of any welding process if success is to be attained. The man that thoroughly knows the subject, knows the materials with which he works and how to get the best results from them, is the one who will make the

greatest saving and produce the best work. It is of fundamental importance that this be considered in any attempt to develop autogenous welders in railway shops.

Employment of Returning Soldiers

We read much in the newspapers concerning what is to be done with the returning soldiers. Too many of us look upon it as a government proposition. To a certain extent it is, of course, but to a very large extent it is up to every individual employer of men. The government should so regulate the affairs of the country that business will improve. It should insist that every one of its departments that involves the occupation of men proceed with the necessary construction to provide markets for the materials from the workshops of the nation and to provide labor for the men. It is not doing so in its department of railroad administration—the contrary is true. Purchases are held down to a minimum in spite of a large amount of deferred maintenance. Attempts have been made, however, to increase the opportunities for employment on the railroads themselves by the introduction of the eight-hour day, which requires three shifts in 24 hours where before two were used. The individual employer of men where he can possibly justify additions to his forces should take care of the returning soldier and particularly the man who has enrolled from his immediate vicinity. Justice requires that this be done. Those of our boys who do come back have served our interests well. They have saved our nation from disgrace and sorrow. Our responsibility to them does not cease with their disenrollment from service. Everyone must seek to make their re-entry into civil life a success.

Patriotism of Belgian Railway Men

It is impossible for American railroad men, not having been subjected to the horrors of invasion during the war, fully to appreciate what it meant to their brothers in Belgium and northern France. We might have had our own ideas as to what we would have done in case our land were invaded but it is practically impossible to realize what it would mean to us. An interesting sidelight on what it meant to the railway men of Belgium and how their patriotism was put to test is vividly given in an article recently published in the Railway Gazette of London. At the time of the invasion the railway engine drivers took as many locomotives into France as possible. Comparatively few mechanics, however, escaped in this way and due to the congestion, by no means all of the engines. Those that were left refused to carry on the service. At first German employees were brought into the country, but later as Germany's demand for men grew and because of many accidents caused by the unfamiliarity of the Germans with the peculiarities of the road, a strong endeavor was made to get the Belgian railway men to work. The Germans offered large increases in wages and as high as $10 a day to the enginemen, but the Belgians steadfastly refused. They and their families were told that they would be deported into Germany, but still this did not alter their attitude.

Railway officers and hundreds of men were put in prison, towns were penalized, but still the men did not give way. Throughout 1916 the German administration in Belgium took every step to increase unemployment with a view of forcing the men through distress to work in Germany. The railway men, however, were more valuable to the Germans in Belgium than in Germany and instances of pressure brought to bear on them, which amounted to regular persecution, are too numerous to mention. At Tournai the railway men were condemned to four months' imprisonment for refusing to work on German engines. Finding them equally obdurate at the end of their sentence it was increased to a year's imprisonment, during which time they nearly died of hunger. At Brussels, despite threats and pleadings, the railway men would give no assistance and finally the Germans ordered the banks to cease any payments of money to their wives and families, the men being deported into Germany, leaving their families to live under charity or to starve. The railway men resisted to the end. They were true to their country and even though they were not privileged to fight on the battlefield, by their patriotism and refusing to work for the Germans, they served their country's cause loyally, despite the privations and persecutions to which they were subjected.

Developments in Locomotive Design

In this issue of the *Railway Mechanical Engineer* is published a description of two of the most recent developments in the design of locomotives, both of which are intended to increase the efficiency of the machine and to reduce its cost of operation. Both are particularly noteworthy and make one think of the wonderful development made in locomotive design and locomotive accessories during the past 10 years. Whence have these improvements come? Who was it that developed them, engaging the best talent in the country for the purpose? There is hardly an improved mechanical appliance on the locomotive today that was not fostered and nurtured and developed by our railway supply fraternity, which has become a tremendously important institution in the railway field of this country. True, many of the embryonic ideas were obtained from railroad men, but the process of investigation, study and development has been carried on by the supply interests. Their incentive, of course, is profit, but the competition has been so keen under past conditions that they have had to provide a product with real merit if they had any hope of success. Under this competition these products have been developed to a high state of efficiency and their savings in the cost of operation have been such that the railroads have found it profitable to buy them. To be sure the railroads have co-operated with the supply companies in working out the designs to a logical conclusion by placing a sufficient number in operation so that the weak points might be determined and corrected.

The manufacturers of these devices have had under private ownership an open and scattered field, so that if a group of men on one railroad could not be convinced that the device was worth trying, there was still plenty of opportunity for convincing others, where, perhaps, operating and maintenance conditions were more favorable, and there were very few meritorious devices that did not find an opening on some road in the United States. Under government control these manufacturers have but one chance to get their devices tried, and that rests with a central committee at Washington which, with such a large task before it, would naturally become over conservative. It is evident, therefore, that with this greatly narrowed field it will be far more difficult to introduce and develop improvements than was formerly the case. In order to get an idea of our condition 10 years hence, under the existing conditions, one has but to think of what has been accomplished during the past 10 years under private management. Would we have had the air brakes we have today? Would the brick arch have been in such extended use as it is today? Would an attempt have been made to introduce feedwater heaters, reverse gears, stokers, superheaters and the many other noteworthy improvements which have met with success? Does this nation realize what an important factor the railway supply interests have been in the development of railway equipment? To remove their incentive for further development and to make it more difficult for them to introduce improved devices will seriously retard further growth.

Equipment Standardization in England

As in the United States the germ of standardization has taken root in England. Sir John A. F. Aspinall, general manager of the Lancashire & Yorkshire Railway, in a presidential address to the Institution of Civil Engineers, strongly opposed this tendency. The conditions in England are somewhat like those of the United States as far as the necessity for having several designs of locomotives to meet the physical conditions is concerned. They are unlike the United States in that a comparatively small amount of equipment was interchanged between the roads before the war. There has been, therefore, no demand for standardized details of construction as there has been in this country. Sir John, however, appreciates the possibility of standardizing to this extent, but argues strongly against extreme standardization.

Assuming that the possibility of seven types might serve the requirements of the English roads he calls attention to the fact that these types will have to be split up into various classes to enable them to deal with the work in all parts of the country without reducing loads. But he says, "Assuming that the seven types will do all the work, the question of maintaining those types for a long period of years depends on the march of progress; and if you look back over a series of years you will find that each period of, say, 10 years on some lines and 15 years on others, calls for great changes in the locomotive brought about by changes in traffic conditions." Thus he goes on to show that the number of classes must be increased in the future, for true economy demands that the machines be kept absolutely up to date.

The individual railway companies have, as in this country, developed an admirable system of duplication which it would be very costly to change and he points out that inasmuch as it would be impracticable absolutely to replace the present designs with standard designs, the transition period would at least extend over 25 years. This will be very expensive—"As the money to be saved on new construction will be trivial and will be much more than wiped out by the interest on the greatly increased value of stores at workshops and outdoor locomotive sheds, necessitated by the introduction of new parts." He quoted the address of Alba B. Johnson,* president of the Baldwin Locomotive Works, before the Chamber of Commerce last year and finds confirmation of Mr. Johnson's views in the growth of locomotive power in the United States during the past 15 years. In speaking of standardization as a bar to progress he says:

"In pressing forward the all-important question of the further standardization of parts, nothing should be done to prevent the acceptance of new ideas which tend toward the improvement of conditions and the economy of operation, though a nicely balanced judgment will often be required to decide between the acceptance of some excellent new idea and the economy to be maintained by the retention of parts which are absolutely interchangeable.

"In the world of mechanism there can be no finality, and we ought not to look forward to finality if we are to keep pace with other nations. The brightest ideas of many minds may easily be killed by over-standardization, and one has but to look at the motor car industry to see how the inventive brains of many of our countrymen have been stimulated by the varied requirements of motor travel to produce some of the most beautiful mechanism in a number of forms, many of special engineering merit. One trembles to think how the too enthusiastic theoretical standardizer could in this case have put a stop to practical progress, and sterilized the best efforts in this great modern industry, while the well thought out standardization of many details and minor parts has helped the manufacturer to purchase parts in a competitive market."

*See *Railway Mechanical Engineer*, May, 1918, page 246.

It is exceedingly interesting to read the opinion of so great a man as our neighbor across the sea on this tremendously important problem. It coincides with the thoughts of our ablest men in this country. We have only to think where we would be today had standardization as it was promulgated the first of last year been enforced 10 years ago to realize where we will be 10 years from now if the present plan of the Railroad Administration persists.

All Sorts of Plans for the Railroads

Twice before, in recent history, railroad men, bankers, politicians and shippers have had an opportunity to air their theories of railroad regulation. Once, in 1914, before the Hadley commission, and once, in 1916-17, before the Newlands committee, but never before has there been such an opportunity as at present for general publicity for different theories of railroad regulation. During the entire month of January the Interstate and Foreign Commerce Committee of the Senate was in session, hearing whomsoever could speak with some show of authority on this question. Probably the most important testimony was that given by the Interstate Commerce Commission, the counsel and representatives of the railway executives, and the representatives of the Association of Owners of Railroad Securities. Naturally, the Interstate Commerce Commission was for an extension and a continuation of its authority with the right to fix minimum as well as maximum rates and to pass upon new issues of railroad securities.

The outstanding feature of the railway executives' plan was the creation of a new cabinet office with a secretary of transportation to fill this office. His duties would be that of assuming the responsibility for adequacy of rates. In addition, railroad companies would be permitted to incorporate under federal laws instead of state laws, and federal regulation would be substituted for state regulation.

The Association of Owners of Railroad Securities, which is an association formed by S. Davies Warfield, president of the Continental Trust Company of Baltimore, with a membership consisting of insurance company officers, savings bank officers, etc., is opposed to the secretary of transportation idea and to federal incorporation, but wants a law passed which will guarantee to the railroads rates sufficient to yield a minimum fixed return on their securities.

It will be seen that in all of these plans, the maintenance of healthy competition is essential. In other words, the dream of economies under a unified railroad administration is apparently recognized as a dream by nearly all the classes of men who are giving their views to the Senate committee. Even Clifford Thorne, representing various shippers, is opposed to government ownership and government operation. Only Mr. McAdoo and his successor in office, Walker D. Hines, continue to urge retention of the roads by the government for five years. The retirement of William G. McAdoo as director general, and the assumption of that office by the former assistant director general, Walker D. Hines, was effected without any immediately apparent change in policy of the Railroad Administration. Mr. Hines takes up the task of urging a five-year retention of the roads in the same vigorous spirit that Mr. McAdoo gave to it.

NEW BOOKS

Proceedings of the Traveling Engineers' Association. Edited by W. O. Thompson, secretary. 478 pages, 6 in. by 8½ in., illustrated, bound in leather. Published by the association, W. O. Thompson, secretary, care of general offices, New York Central, Cleveland, Ohio. Price $1.

This is the official report of the twenty-sixth annual meeting of the Traveling Engineers' Association, held in Chicago September last, which was one of the most successful conventions ever held by this association. The subjects discussed covered particularly the duties of traveling engineers

and the opportunities they had for helping the nation win the war. Fuel economy was practically the keynote of the entire convention, and much valuable information was presented on this subject. Several interesting subjects of more technical interest were discussed, among them being proper maintenance of locomotives, superheater performance, improvement in the air brake service and maintenance, locomotive cab and cab fittings on modern locomotives, and engine failures. This volume contains an address by Frank McManamy, assistant director of operation, United States Railroad Administration, outlining the importance of the duties of the traveling engineer, and a paper on "The Railways in the War," by Samuel O. Dunn, editor of the *Railway Age*. Eugene McAuliffe, manager of the Fuel Conservation Section, presented a paper on railway fuel conservation.

The Starrett Book for Machinists' Apprentices. By Howard P. Fairfield, assistant professor machine construction, Worcester Polytechnic Institute, and Carl S. Dow, S.B., editor-in-chief Practical Mechanical Engineering and Practical Shop Work. Fourth edition, 176 pages, illustrated, 4½ in. by 7 in., bound in leather. Published by the L. S. Starrett Company, Athol, Mass. Price 50 cents.

While this book is essentially for the apprentice rather than the expert machinist, many machinists will find it of much interest and value, as it is intended to answer questions as to how to do the everyday work of the average machine shop. The aim in preparing the book was to select the elementary features most essential to the advancement of machinists' apprentices and students in technical and manual training schools. It is intended to give a portion of the instruction ordinarily given by the teacher or by more experienced machinists and will also serve as a reference book for data not to be memorized. The different classes of work are taken up separately; the most common errors are pointed out and the correct practice indicated. Attention is given to the proper use and care of tools, the reading of micrometers and verniers, bench work, lathes and lathe tools, grinding, belts, gears, etc. Distribution is being made exclusively through the hardware dealers handling Starrett tools.

An Investigation of Twist Drills. By Bruce W. Benedict and W. Penn Lukens. 139 pages, illustrated, 6 in. by 9 in. Bound in paper. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill.

This bulletin contains an account of a series of experiments to disclose certain facts regarding the performance of metal drills. One-inch drills of several standard makes, and cast iron test blocks made in the shop laboratories, were used. The power required for different speeds and rates of feed was noted in all tests and the thrust and torque of the drill were recorded by special dynamometers. The economical helix angle, point angle, clearance angle, speed and feed were determined, and the effect of pilot holes was shown.

Some of the more important points brought out by the investigation are the following: The lowest power consumption was attained with helix angles from 35 to 40 deg., while in cast iron an angle of 30 to 35 deg. gave the best average endurance. For drilling holes at depths of more than 3 in. a drill with a large helix angle gives the best results. In general a point angle of about 110 deg. seems more satisfactory than the usual angle of 118 deg. A peripheral clearance of 6 or 7 deg. showed the maximum endurance. An edge angle of 130 deg. is recommended for all but the heaviest feeds. This angle may be decreased for light feeds and increased for heavy feeds. Drills with concave cutting edges and large chip spaces showed the lowest power consumption and the greatest endurance. The endurance of a drill may be increased from three to ten times by simply rounding the sharp corners at the edge. This has the effect of preventing the corners from burning.

Bulletin No. 103 may be had gratis from the Engineering Experiment Station, University of Illinois, Urbana, Ill.

COMMUNICATIONS

THE SUBTLETY OF STANDARDS

Louisville, Ky.

To the Editor:

There is scarcely a word more heavily laden with deceit than that of STANDARD. Its meaning is sadly misinterpreted even by men of intelligence. It conveys to the lay mind that something long in dispute and unsettled has been agreed upon. We think of it as something carefully worked over, hammered and boiled down until nothing remains but the essence. It suggests a system or device or a method which may be followed by the unknowing and assumes that that which has long been in a state of unrest and turmoil is forever out of the way, pigeon-holed, ticketed and labeled and finished. Tamper with what you may, criticise as you feel disposed, but keep away from that which is immobile, permanent, fixed—OUR STANDARD. Whose Standard?

While investigating one of our big new U. S. Standard Mikado engines, I found the throttle lever altogether too short for easy handling for the average engineer. Cab fittings and their proper location are among our most troublesome things for the reason that no two men will agree as to the exact location of anything. It has been our plan to take several opinions under advisement and, by pooling the ideas, select the best average and go ahead. By this means we think we have attained a fair degree of success and our cab arrangement is said to be good, in fact so much so that we are occasionally beguiled into speaking of it as "our" Standard.

As a matter of fact every new engine suggests modifications of one kind or another, and in riding with our men from point to point we get information regarding cab fittings and fixtures which cannot be had in any other way. Our cab arrangement is excellent, for our engines and our men are pleased with it, but under no circumstances would we say it is adaptable to every railroad. Our house appears to be in order and we like our furniture, then why should we discard that which suits a majority of our operators to adopt a doubtful design of another's invention? Standard Practice data are useful, very useful, but they must not be substituted absolutely for an experience which has proven its practice.

"Just as soon as we have become accustomed to the new order of things we may like the Standard better," I hear some one say. Not so. It is impossible to get used to a short throttle lever and equally impossible to do one's best with an inconvenient arrangement of cab fittings. Whose business is it to correct these things and see that they do not appear on the next lot of engines? Which of the manufacturers will take the pains incident to obtaining the information it has taken us years to accumulate? Whose standard is it that we are trying to swallow without making faces? The deceitfulness of riches is not to be compared with the deception lurking in the word "Standard."

It has gotten some of us into ten or fifteen years of extra trouble which we will doubtless pass on to our successors, an unwelcome heritage. We can hardly hope to outlive it. Those "three reasons * for standardizing locomotives" is the strongest possible testimony to the subtlety of the word which seems to have tricked a lot of old heads into thinking that the impossible might be pulled once anyhow on the unsuspecting.

Millard F. Cox.

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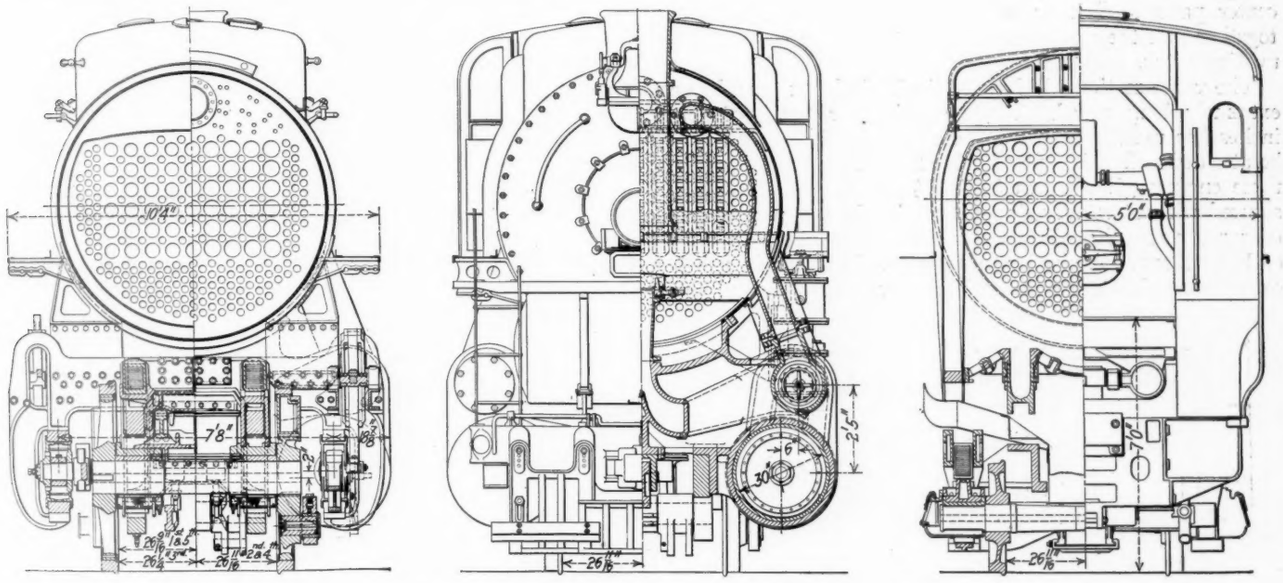
*See *Railway Mechanical Engineer* of January, 1919, page 2.

PENNSYLVANIA LINES 2-10-2 LOCOMOTIVE

New Features Include Four Point Suspension System, Two Radial Axles and Road or Switching Pilot

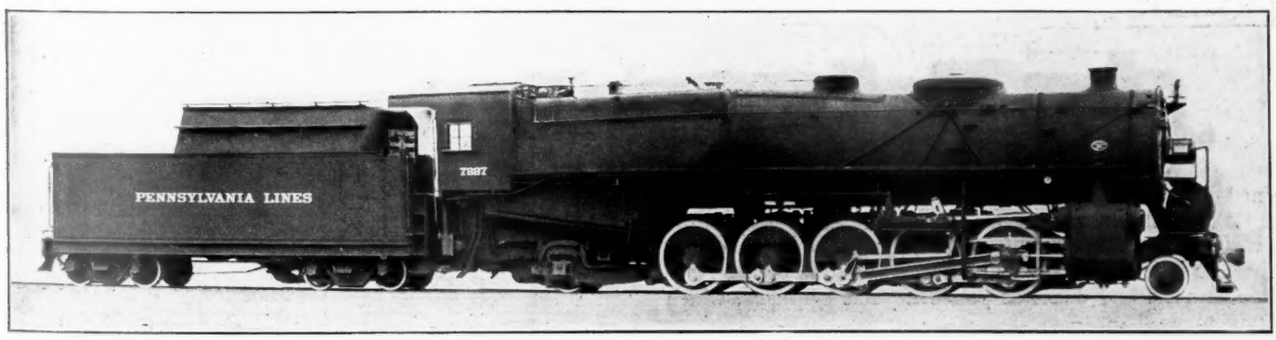
THE Pennsylvania Lines West of Pittsburgh have recently received from the American Locomotive Company several locomotives of the 2-10-2 type which are notable for two reasons. The total weight is greater than for any engines of this type previously built, and yet they are able to operate on 23 deg. curves. Although these locomotives are extremely heavy they are in service on a division with low grades. All that have been received thus far are on the lines running from Conway Yard, near Pittsburgh, Pa., to Ashtabula, O., and Erie, Pa. The majority of the traffic being handled is ore moving from Ashtabula to Conway and coal from Conway to Ashtabula. The ruling grade on this line is 0.3 per cent, and the engines are handling approximately 85 loaded ore cars. The locomotives have a rating of 7,100 adjusted tons which amounts to about 6,000 actual tons.



Sections of Pennsylvania Lines West 2-10-2 Type Locomotive

The Consolidation type has long been the standard for freight service on the Pennsylvania Lines West of Pittsburgh. The recent designs developed practically the limit of the tractive effort obtainable with four driving axles. As the traffic conditions demanded heavier motive power it was felt that the increase in tractive effort which would be secured with the Mikado type would be so slight that it was best to go to the use of five driving axles. This 2-10-2 type, which is known in the company's classification as the N-1s, was therefore designed. Orders have been placed with the American Locomotive Company for 35 of these locomotives, and 25 are to be built at the Baldwin Locomotive Works.

Locomotives with five coupled pairs of driving wheels and a lateral motion driving box on the front axle cannot traverse curves sharper than 16 deg. In order to enable these engines to pass 23 deg. curves both the front and rear drivers are fitted with the Woodward floating axle. The tires on these wheels are set 53⅛ in. apart, and the main driving wheels have blind tires. In order to permit of coupling on sharp curves a pilot drawbar with a long shank is used and the pilot beam casting is cored out where the coupler enters, so that it can swing some distance on either side of the center line.

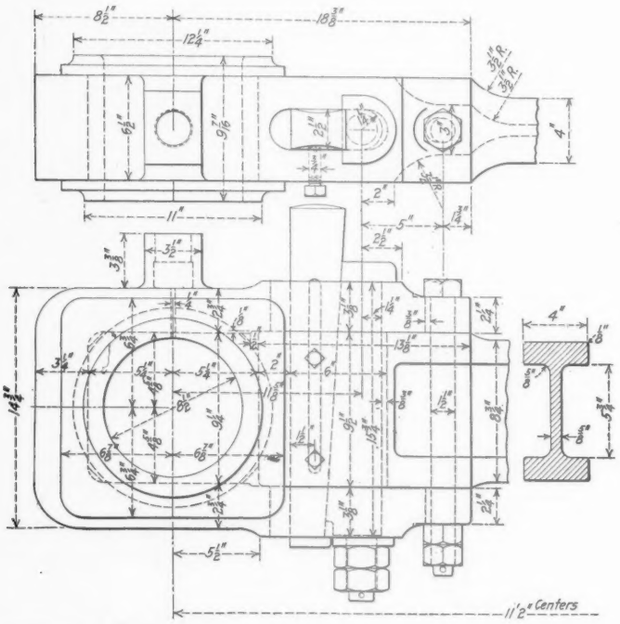


2-10-2 Type Locomotive for the Pennsylvania Lines West

While designed primarily as a road engine this type is well adapted for use in hump yard service. A unique design of cast steel road and switching pilot worked out by representatives of the Pennsylvania Lines West has been applied which makes it possible to use the engine in either service without the delay incident to removing the pilot and applying footboards or vice versa. Details of the pilot are shown in one of the illustrations.

The equalizing system is a very unusual departure from standard American practice. Instead of the three point suspension introduced by Eastwick & Harrison in 1838, which has been universally used in this country for many years, a four-point suspension has been adopted. The leading truck is equalized with the front pair of driving wheels, the three center pairs of driving wheels on each side are equalized together and the rear pair of drivers are equalized with the trailing truck.

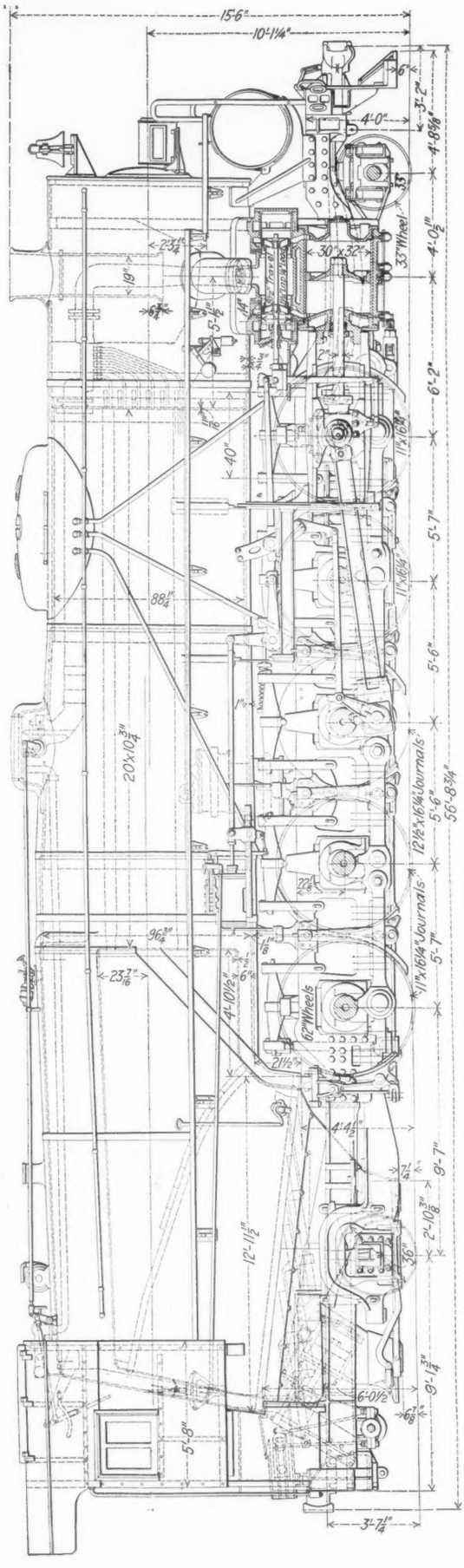
The valve motion which is of the Walschaert type, has an extremely long travel. While a full gear travel of seven inches has usually been considered the maximum that could be attained with this type of valve motion the design used on these engines gives a travel of 8½ in. The long travel is secured without excessive angularity by the use of a long radius rod and a long link combined with an eccentric crank of large throw. A similar arrangement has been in use for some time on a Consolidation locomotive, and the results ob-



Back End Main Rod; Pennsylvania Lines West 2-10-2 Locomotive

tained have demonstrated that the theoretical advantage of the long travel is borne out in actual practice. The steam lap of the valve is 1⅛ in. and the lead ¼ in. The 14-in. piston valve has a long spool and the passages to the cylinder are made as short and direct as possible. The cylinders, which are 30 in. in diameter with a 32-in. stroke, have a Z-shaped piston with a cast steel center and a cast iron bull ring. The cylinder lubrication is effected by a two-feed force feed lubricator which is attached to the left steam chest. A two-feed hydrostatic lubricator located in the cab is provided to supply oil to the air pumps and the cylinders of the stoker engine.

The boiler has been designed with a view to securing adequate firebox volume, and a large fire area through the tubes. The firebox is fitted with a brick arch and has a combustion chamber approximately 5 ft. long. There are 54 flues of



Elevation of Pennsylvania Lines West 2-10-2 Type Locomotive

5½ in. diameter, and 196 tubes 2½ in. in diameter. While the total heating surface is decreased by the use of the larger tubes, experiments have demonstrated that as tubes are lengthened beyond a certain point the evaporation does not increase proportionately. The most desirable ratio of length to internal diameter is approximately 100, and by using 2½ in. tubes this ratio is secured. Although the locomotives are now operating with a boiler pressure of 205 lb., the boiler is designed to carry 250 lb. The weight on the driving wheels is sufficient to permit of securing additional tractive effort, still maintaining a satisfactory factor of adhesion. The Crawford underfeed stoker is applied to these locomotives. The driving cylinder is placed in inclined position on the left side of the engine.

The location of the main reservoirs presented a difficult problem. It was finally decided to place a 36-in. diameter reservoir ahead of the cylinder saddle. The braces leading from the smoke box to the frame are steel castings, which also serve to support the reservoir. A three-rung ladder leads

Weight of engine and tender in working order	642,400 lb.
Wheel base, driving	22 ft. 2 in.
Wheel base, total	41 ft. 11½ in.
Wheel base, engine and tender	82 ft. 7¼ in.

Ratios

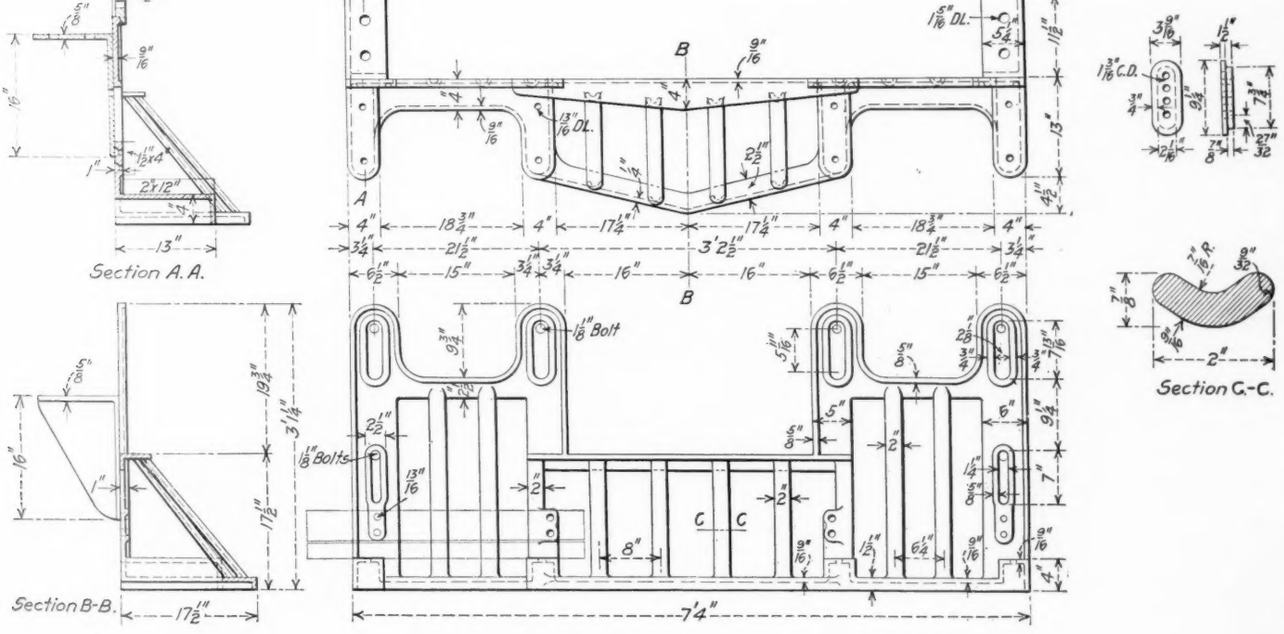
Weight on drivers ÷ tractive effort	4.34
Total weight ÷ tractive effort	5.38
Tractive effort × diam. drivers ÷ equivalent heating surface*	701.67
Equivalent heating surface* ÷ grate area	89.4
Firebox heating surface ÷ equivalent heating surface,* per cent	5.21
Weight on drivers ÷ equivalent heating surface*	49.1
Total weight ÷ equivalent heating surface*	60.9
Volume both cylinders	26.18 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	273.1
Grate area ÷ vol. cylinders	3.06

Cylinders

Kind	Simple
Diameter and stroke	30 in. by 32 in.

Valves

Kind	Piston
Diameter	14 in.
Greatest travel	8½ in.
Outside lap	1⅛ in.
Inside clearance	⅜ in.
Lead in full gear	¼ in.



Cast Steel Pilot for Both Road and Yard Service

from the pilot beam to the running board. The air piping is arranged under the running board bracket, which is designed especially to receive it. Two sets of 13-in. by 12-in. brake cylinders are set between the first and second drivers, both working on the same levers and operating the shoes on all five pairs of driving wheels. An 8½-in. cross compound compressor is used. Among the specialties applied are Pyle National headlight, Commonwealth locomotive cradle, and Delta trailing truck, Ragonnet power reverse gear, and Barco flexible joints.

The principal dimensions and ratios of the locomotives are as follows:

General Data

Gage	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	80,942 lb.
Weight in working order	435,400 lb.
Weight on drivers	351,300 lb.
Weight on leading truck	23,100 lb.
Weight on trailing truck	61,000 lb.

Wheels

Driving, diameter over tires	62 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	12½ in. by 15 in.
Driving journals, others, diameter and length	11 in. by 15 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6½ in. by 12 in.
Trailing truck wheels, diameter	36 in.
Trailing truck, journals	7½ in. by 13⅞ in.

Boiler

Style	Conical Belpaire firebox
Working pressure	†205 lb. per sq. in.
Outside diameter of first ring	90¼ in.
Firebox, length and width	80 in. by 144 in.
Firebox plates, thickness—	
Back and sides ⅜ in., crown ⅞ in., throat ½ in., tube ⅝ in.	
Firebox, water space	6 in.
Tubes, number and outside diameter	196, 2½ in.
Flues, number and outside diameter	54, 5½ in.
Tubes and flues, length	20 ft. 10¾ in.
Heating surface, tubes and flues	4,302 sq. ft.
Heating surface, firebox, including arch tubes	423 sq. ft.
Heating surface, total	4,725 sq. ft.
Superheater heating surface	1,618 sq. ft.
Equivalent heating surface*	7,152 sq. ft.
Grate area	80 sq. ft.
Center of boiler above rail	10 ft. 1¼ in.

Tender

Tank	Rectangular water bottom
Frame	Cast steel
Weight	207,000 lb.
Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	10,000 gal.
Coal capacity	20 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.
†Designed to carry 250 lb. per sq. in. pressure.

RECENT PAPERS ON FUEL CONSERVATION

Abstracts of Railway Club Papers Prepared by Fuel Experts Describing Methods for Saving Coal

PAPERS on fuel conservation were presented recently at the New England Railroad Club and the Southern and Southwestern Railroad Club by Robert Collett and B. J. Feeney, respectively, both of the Fuel Conservation Section of the Railroad Administration. A letter was also circulated by Joseph Harrington of the Fuel Administration, on the removal of soot by burning salt. All three of these are abstracted below:

IMPORTANT POINTS IN FUEL CONSERVATION

BY ROBERT COLLETT

Assistant Manager Fuel Conservation Section, U. S. Railroad Administration

A recent request from General Pershing called for six million tons of fuel to be shipped abroad. Our present shipbuilding program was estimated to require fourteen million tons of coal, merely to make and transport the steel. And for the eight million tons of vessels, it will require five tons of coal for each ton of shipping which leaves the ways. Each 15,000-ton ship that leaves our harbors for Europe consumes about 3,000 tons of coal or 12,000 barrels of fuel oil. Before the war, ships coaled abroad and made the round trip. Now the reverse is true. We can readily see, therefore, that the need for conservation, aside from cost is such as to challenge our best efforts. By reason of the large corps of fuel inspectors under the Federal Fuel Administration, aided by the railroad fuel inspectors, who have also been given federal authority, the general quality of the fuel has been, and will continue to be, very much improved. The miners have responded wonderfully. Better car movement has also helped.

ORGANIZATION.

It is our recommendation that one general man without other duties than fuel conservation, be charged with general supervision, reporting to the chief operating or chief mechanical officer; if to the latter, it should be understood by all departments that matters so requiring will be referred to the chief operating officer whose support, it is needless to add, will be given all practicable suggestions. The particular reason for this is, that many features vitally affecting fuel performance can only be handled as a system matter. The monthly fuel cost should be furnished at the earliest possible date after the close of each month to all divisional as well as general officers, and be made a subject of discussion at staff meetings. The plan of having fuel conservation committees, as a number of roads now have, is a good one.

Where practicable, each road foreman of engines or supervisor should have a certain number of crews and engines and be thoroughly familiar with the fuel costs in such service. We will assume one road foreman of engines with an assistant, and one traveling fireman—which is more supervision than is usually provided—has 50 engines in service at all times under his direction. At present costs these 50 engines are worth, if at all modern, we will say $40,000 each, or a total of $2,000,000. We will estimate they will burn 300 tons of coal each month at $6 per ton, a fair average for New England; this gives a fuel cost of $1,800 per engine per month, a total of $90,000 per month, or $1,080,000 per year. This supervision then is virtually responsible for the proper operation for every minute it is in actual service, of $2,000,000 worth of machinery and the proper use, so far as the work of the crew is concerned, of $1,080,000 worth of fuel annually. It is very natural, therefore, they should be anxious to make a good return for their stewardship.

PERSONAL EXPERIENCES ON A LARGE ROAD.

Several years ago the writer was assigned to the work of fuel economy on quite a large railroad, reporting directly to the general manager. In this experience I early learned that the one thing that goes further than anything else in obtaining results, is the unqualified support of the officers—from the chief operating officer down—which should be manifested by a personal interest *in,* and familiarity *with,* what is going on in the work. The important factors which it was my duty to study and control, as outlined by the general manager, were as follows:

Waste of fuel by reason of engines being delayed on the road.
Waste of fuel by engines being kept under steam unnecessarily at terminals.
Improper handling of the engine.
Excessive use of fuel by firemen.
Engines not in good condition.
Fuel not up to contract specifications.
Shortage of coal reaching pockets.
Fuel used for other purposes and improperly charged to engine use.
Any other matters that may require attention.

Locomotive Performance Sheet.—By the performance sheets we were enabled to make a very close study of fuel distribution, that is, the charges to individual engines and other miscellaneous purposes. A daily record was kept by charging the coal consumed on each trip, including that used at terminals, against the gross ton-miles in freight service and passenger car miles in passenger service for the trip. We found that no matter how closely we watched the distribution feature and although the law of averages worked out very satisfactorily for a given class of service, we could not depend on the performance sheet alone to locate excessive consumption. There are so many factors that can influence the performance even on similar runs, that a very close personal knowledge of the conditions of all of the locomotives and also close contact with the crews, shop forces and despatcher's office is necessary.

Waste of Fuel by Engineers Kept Under Steam Unnecessarily at Terminals.—It had been the practice with us and it is not at all uncommon for the mechanical department to keep engines ready for service at all times. This method was reversed and the transportation department gave three hours' notice for the required engines. All of the time above three hours the engines were held under steam, was charged at a rate determined by tests for the various class of service and considered as excessive fuel used at the terminal. This is a matter for local handling, but requires very close watching. Firemen instructors should spend a certain portion of their time educating fire-tenders and there should be terminal

fuel committees, consisting of the master mechanic, yardmaster, and others. Proper division officials should be looked on as responsible for economical use of fuel at terminals, including stationary plants.

Improper Handling of Engines.—Engineers are quite naturally anxious to make a good performance. The statement has sometimes been made that "You can't teach an old dog new tricks." That is not my experience. Any man who can successfully hold down a job of running an engine over a period of years, I maintain not only *can,* but has the disposition *to* learn the most economical methods of operation. We will presume a man is not quite so skillful with the reverse lever and throttle or injector as some other men. Let the road foreman or supervisor go with him and say, "We want to see, or the boss wants to know, what is the best that can be done on this run in the way of fuel. I may make a few suggestions, but I will take the responsibility for making the time, etc." He may even handle the engine or fire for a part of the way. Let a note of commendation come back from the general manager or superintendent on the good performance and you will find that it will have the effect of encouraging any man to make a close study, as to how he can improve his methods. Another thing, the enginemen see things neglected which to them seem of great importance, and which causes them to believe that fuel economy is not really so much the desire of the management, or they would have been corrected. It is desirable that the crews be advised as to what steps are taken to remedy defective conditions which come under their observation and to which they call attention.

Excessive Use of Fuel by Firemen.—Not unlike many other roads, our plan was to give new firemen a letter to be signed by three different engineers, when in their opinion he was qualified. We found they did not always ride with crews who were the best instructors. We then arranged to select the crews they should ride with and whom we knew would train them properly. We also established the first, second and third year progressive examinations and made a rule that as nearly as practicable, the road foreman of engines would approve the application of new firemen before they entered the service for pay. In the past eighteen months scarcely any rule would apply in the employment of new men, but speaking in general it is possible to attract good men for the position of locomotive firemen.

I believe it worth while to maintain a competent force of traveling firemen or firemen instructors. There are always firemen on every division of the railroad who are very skillful, and the other firemen should be taught their methods. Everything depends on the new firemen getting a proper start and this has not been given enough consideration on the average railroad. The treatment accorded by the engineer, especially with new men, is important.

Engines Not in Good Condition.—Aside from the support of general officers and thorough co-operation between all departments, the condition of the locomotive is the greatest factor in the economical use of fuel. We will pass the matter of design and well known appliances with the statement that appliances, of whatever nature, tend to make the engine more complicated and require that they be properly maintained and operated. Certain devices operating under 100 per cent condition guarantee a certain result, but it is sometimes found that practically all of the benefits of the investment are lost by reason of lack of attention to detail, in its care.

Definite front-end and nozzle arrangements should be established and maintained at standards proven to be the most economical for the grades of fuel to be used. Air openings through ash pans should not be less than 15 per cent of the grate area, and preferably more than this. Tight steam pipes, front ends, tight valves and cylinder packing, grates properly maintained and first class steam distribution are the more important items. Engines cannot be in too good condition. If properly encouraged and especially if they know just what it means in dollars and cents in fuel costs, engineers will assist by their reports in keeping engines in good condition.

It is a good plan for the road supervision to ride engines for the first trip out of shop or during the breaking-in period, giving the shop superintendent or master mechanic a detailed report. These reports can be gone over at the staff meetings of the shop superintendent or the master mechanic with their foremen. We should also commend them for their good work. There should be the closest co-operation between the road supervision and the terminals and shops. It has been often stated that if all of the unnecessary work occasioned by improper reports could be avoided, all of the necessary work could be done.

SUGGESTIONS FOR FUEL SAVING

BY B. J. FEENY
Supervisor, Fuel Conservation Section United States Railroad Administration

The railroads are playing a very important part in the conservation of fuel, as they fully realize the importance of so doing not only because it is a part of the government conservation program, but also on account of the great increased cost of fuel, coupled with the increased cost of labor and materials. At all fuel conferences great stress is laid on the necessity of good locomotive maintenance, constant education of enginemen and firemen, hearty co-operation and a more complete and thorough understanding of the importance of fuel conservation by operating officers. All these things can be accomplished if an effective organization is put on each railroad. There should be a general staff officer in charge of fuel conservation, who should give his entire attention to the conservation of fuel on locomotives, in shops, at terminals, at water stations and for all miscellaneous purposes. He should also give attention to the preparation of fuel received, to its quality and should direct its transportation to and its handling at fuel stations.

Constant and good supervision is necessary to promote fuel conservation, so that all users of fuel may be taught to use it economically in the shortest possible time. We must constantly train our enginemen and firemen so that they will get the highest degree of economy which is consistent with good practice. They should know that every available bit of energy is produced by the fuel that is burned. What good results could be accomplished if the engineers and firemen would have in mind the saving of coal from a point of working the engine to the best advantage, with a view of getting results in the most economical manner. The enginemen should have the assistance of all officers and employees who have anything to do with the purchase, handling and preparing of fuel for use. Fuel economy starts with its purchase and ends at the cinder pit.

The coal on the tender should be used while it is in the best condition and should not be carried on tenders from shopping to shopping. Any practical device that will move coal forward to the fireman should be put on the locomotive tender. Shoveling coal forward, in the absence of a coal pusher, will answer the purpose. The supplying of coal to locomotives should be similar to the method of supplying oil. Daily experience indicates that the coal ticket as prepared by the engineer is not dependable; the coal chute foreman is the best judge of the amount of coal delivered to each engine.

An important subject that should be followed up is the firing up of locomotives in advance of leaving time. The practice of keeping locomotives under steam should be discontinued. Where a locomotive is fired up a long time in advance of leaving time, the front end netting becomes stopped up and the fire becomes dirty, which often results in the engine not steaming and failing on the road. To provide a safe margin, two or three hours before leaving time is

early enough to start a fire in a locomotive intended for any service. Any small defect that heat would produce would make itself apparent in sufficient time to permit workmen to correct it or furnish another engine without delay.

There are advantages other than saving of coal in permitting engines to cool off. Workmen are offered more opportunity to work around cool engines; and they permit any character of inspection and good workmanship. The liability of engines moving while under steam is eliminated and there is no expense for engine watchmen to put water in locomotives standing partly fired, which causes damage to flues and firebox; it also avoids unnecessary moving of engines. There is not an element of locomotive maintenance that does not in some degree affect fuel consumption. We should organize and concentrate roundhouse forces so that all work is done on washout and monthly boiler inspection days. This also will allow for quick turning of power on all other days.

In starting fires in locomotives considerable green coal falls through the openings in the grates. After an engine is taken out of the roundhouse the ash pans should be dumped and the coal reclaimed. In many instances there is enough green coal left in the ash pan to haul one thousand tons of freight one mile. Locomotives tying up at points where no roundhouse facilities are available should have their fires banked when the engine is placed at rest and the fires should not be cleaned until two hours before the listed time. This allows the fire cleaner an opportunity to work with cold ashes instead of a hot fire. The ashes remaining in the locomotive all night prevent air from passing through the grates and flues, consuming fuel and reducing the temperature of the boilers with bad effects on the fire-box and flues.

The covering of stacks on locomotives when fires are knocked out should receive more attention, as locomotives with stacks covered retain steam pressure from five to seven hours longer than when they are left uncovered and air is allowed to circulate through the flues. It also prevents the flues from sweating, which often causes engine delays.

The front end inspection of locomotives through the smoke box door should be extended to making inspection through the smoke stack. Many locomotives are in service today with petticoat pipes out of line or hangers and bolts loose, table plates loose, and with holes in them, blower pipe out of line, air pump exhaust pipe out of line, exhaust tips gummed or loose or with bridges in them. Experience has taught that just opening the front door and making an inspection from that point has not given the desired results. Periodical inspections of front ends for air leaks should also be put into effect.

A great many of the older locomotives are running today with draft sheets set so close to the tubes that gases strike them with such force as to stop the flow through other tubes, thus causing excessive heat at the fire door. All draft sheets should be set far enough away from the flue sheet so that the gas, after reaching the end of the flues may travel freely to the atmosphere.

The uniform drafting of locomotives should receive the necessary consideration, in order that the benefits resulting from the proper sizing of coal and the proper handling of it by engineers and firemen may be secured. Records show that firemen who do well on certain locomotives are absolute failures on other engines of the same class, on account of the variation of exhaust tips and other front end irregularities. Often times poor performance is secured where competent firemen are doing their best. Some railroads have already adopted uniform nozzle openings. A record should be kept showing the size of the nozzle opening in every engine and every change in the size of the nozzle should be recorded. A reduction of 1/8 in. in the diameter of the nozzle will waste one ton of coal over an average division.

The saving of coal and the increased efficiency to be produced by testing superheater units at regular intervals of 30 days will no doubt more than offset the expense of examination. Superheater units leaking can waste large quantities of fuel though the locomotive may perform apparently satisfactory service. All flues should be thoroughly cleaned. Many times this work is apparently done, but a closer investigation develops that the tubes are given a "lick and a promise" cleaning only. When flue cleaning is done in this manner, engines will not steam freely and will be wasteful of coal. Such a condition will not exist if there is a capable inspector around.

Much emphasis must be laid on the necessity of keeping boilers clean and free from scale. Tests indicate that 1/16 in. of scale will increase the fuel cost 15 per cent. Good feed water is not always obtainable, but for the sake of economy railroads can well afford to spend money for purifying plants, or any practical means of treating water in tender tanks or locomotive boilers. With any of these treatments, regular and good boiler washing is of vital importance. The inspection of boilers after being washed out is very important. Fuel and labor saving devices must always be kept in best of condition; failure to do so will result in vast waste of fuel. Representatives of the manufacturers should be called on when devices are not giving proper results.

Steam heat pipes on locomotives should be covered from the source of supply in the cab to the rear of the tender. Many locomotives are in service today with 45 ft. of steam heat pipe uncovered and the connection between the engine and tender so low as to be dragging in the snow. In some cases the tender leaks and the drippings fall on the steam heat pipes, condensing the steam in addition to the loss by radiation. Consider how much condensation this 45 ft. of exposed pipe will create on a locomotive on a cold, stormy day, fanned by the winds. The loss does not stop here; in severe weather, on long passenger trains, steam traps and pipes become frozen, due to excessive condensation and it becomes necessary to delay passenger trains to thaw the pipes and again get steam through the train. These delayed passenger trains delay other trains on the road. The steam pipe to the air pump should be placed under the locomotive jacket and all other locomotive steam pipes exposed to the weather should be covered.

Every pound of unconsumed coal that finds its way to the ash pit is a direct loss. Supervisors of fuel can procure good results by meeting engines on arrival at the cinder pit and making clear to the enginemen and firemen the amount of fuel lost by not keeping fires in proper condition.

Close attention must be given to the fuel used at stationary power or heating plants, at terminals, roundhouses, pumping stations, and elsewhere. A large share of fuel is used at these places and frequently wastefully used. A large loss of fuel is sustained due to exposed steam surfaces; in many places steam pipes are laid in or on the ground without any protection from the weather, causing wasteful condensation. When conduits are not available these lines should be located overhead and covered. Cover all steam pipes, connections, boilers and manifolds, and stop all air leaks in boiler settings. There should be a more general use of CO_2 recording apparatus and draft gages in connection with the investigation of fuel conditions in power plants. Efforts here will yield a large return.

Compressed air is the most expensive power to produce that is used for railroad shop and yard service. All air lines leading from compressors should be so arranged that each department can be cut out when working hours cease, or when it is no longer required. Fuel bulletin boards should be established at all district terminals. These boards should be used exclusively for fuel bulletins, circulars and graphic statements. Railroads that publish employees' magazines

should see that each publication gives some space to the subject of fuel conservation. Coal gates and coal chutes should be stenciled, "Save Fuel," also other places where coal is handled or used. If every railroad man will but realize his personal responsibility to do his utmost under existing conditions, and if he will in his daily work steadily apply the good practices with which he is familiar, avoiding the poor practices and encouraging others to do likewise, enormous savings in fuel will result.

REMOVE SOOT BY BURNING SALT

Joseph Harrington, administrative engineer, United States Fuel Administration, at Chicago, describes a method for removing soot from the furnace walls and heating surfaces which was called to his attention by C. J. Causland, electrical engineer of the Pennsylvania at Chicago, and Jerome Kohout, chief chemist of the Commercial Testing & Engineering Company, Chicago. He says:

"One of the most difficult problems which conservation engineers in the State of Illinois encounter in the burning of local coal in both steam boilers and house-heating furnaces, is the removal of the excessive deposit of soot and tarry substances on the cold heating surfaces of the boilers. This tar or soot has an insulating value far in excess of any commercial insulator. One 1/32 in. of soot on a boiler reduces the transmission of heat approximately 10 per cent, and 20 per cent for 1/16 in. In view of the well known fact that heating surfaces quickly become covered with soot as thick as the foregoing, the great importance of some method of removing it becomes apparent.

"This process is in brief, the application of common salt to the fire under conditions which will produce dissociation of the sodium and chlorine from the salt and the subsequent combination of these elements with the carbon of the soot to form a substance which then passes off as a gas or drops off of the heating surface. The practice is briefly as follows:

"The fire is put into good condition with a substantial body of hot fuel. Common salt, previously dried, is then thrown or sprinkled onto the incandescent fuel bed in a quantity depending entirely on the size of the furnace. In the case of a household furnace a pound at a time is ample, in the case of a large power plant boiler, four or five scoopfuls may be required. The dampers are kept open so as to maintain the furnace temperature and the salt is allowed to remain until the fumes have entirely disappeared.

"Immediately upon charging the salt, the furnace becomes filled with dense white fumes which may require as much as half an hour to entirely disappear. If results are not secured on the first application, it should be repeated as many times as necessary. Once the heating surface is thoroughly cleaned, a small application every few days is usually sufficient to keep it so."

U. S. R. A. MECHANICAL DEPARTMENT

Abstract of Mr. McAdoo's Report to the President of the Work and Accomplishments of This Section

ON February 9, 1918, Frank McManamy, chief inspector of locomotives for the Interstate Commerce Commission, was appointed manager of the Locomotive Repair Section of the United States Railroad Administration. On July 1, 1918, he was promoted to assistant director of operation, in charge of the mechanical department and his jurisdiction extended to include car repairs, supervision of mechanical standards, and of tests of new devices. Later he was given jurisdiction over the enforcement of federal laws for the promotion of safety for employees.

Methods Adopted for Improving Equipment.—On account of the competition of high wages paid by the shipbuilding plants and war industries generally there was a considerable shortage of skilled mechanical workers in railroad shops. Immediate relief could only be secured by working a greater number of hours. Railroad shops on many of the important lines were placed on a basis of 70 hours per week, and the remainder on 60 hours per week, which was approximately an average increase of 20 per cent in shop hours. In June all shops were placed on the 60-hour-per-week basis, which continued until the signing of the armistice, when arrangements were made for readjusting the hours, which were reduced on November 25 to nine, and December 9 to eight hours per day.

Co-ordination of Locomotive Repairs.—A check of the repair shops indicated that their combined capacity was ample to take care of all of the locomotives if they were properly distributed. Plans were immediately perfected to send locomotives to the nearest available repair shop, regardless of ownership, and to distribute the work so that each shop could be worked to capacity. Under this plan, since January 1, we have transferred 2,065 locomotives to the shops of other railroads under federal control, where they had been given heavy classified repairs; otherwise, these locomotives could not have been kept in service.

Comparison of Motive-Power Conditions.—Accurate comparison of motive-power conditions with one year ago is difficult, because of the varying methods of rendering reports prevalent on the different lines. The improvement in the condition of locomotives is perhaps best indicated by the fact that, notwithstanding the tonnage handled during the year has been the heaviest ever known, there are now stored in good condition and ready for winter service, 1,189 locomotives, while one year ago there was not a single serviceable locomotive in storage. This improved condition is due to the co-ordination of shopwork.

Condition of Freight Cars.—The general condition of freight cars has also shown a substantial improvement since the organization of the mechanical department. The percentage of bad-order cars to revenue cars on line has decreased from 7 per cent in July to 5.3 per cent, which is a decrease of approximately 43,000 in the number of bad-order cars.

GENERAL CONDITION OF EQUIPMENT AND TERMINAL FACILITIES

One of the prime causes for the necessity of government control of railroads and one of the most serious conditions the Railroad Administration was called on to correct when assuming control, was the general bad condition of locomotives and cars. As the Railroad Administration had at that time no mechanical department organized to check up shop practices and handling of equipment at terminals, the Interstate Commerce Commission promptly placed at the disposal of the Railroad Administration the records and personnel of its Bureau of Locomotive Inspection and Bureau of Safety.

The reports showed that in addition to the congestion caused by failure of shippers to unload cars promptly that

a serious situation existed on account of the number of bad-order cars at various terminals and also on account of the general defective, run-down condition of motive power.

Prompt handling of locomotives was seriously hampered by the condition of roundhouses and the lack of facilities at many points to make running repairs to large modern locomotives. Roundhouses built 20 or more years ago for locomotives in service at that time were still being used to house locomotives more than twice the size for which they were designed. Repairs had to be made either out of doors or in open roundhouses with the temperature below zero. Steam pipes, injectors, air pumps, and even cylinders froze and burst, and in many cases locomotives were actually frozen to the track in roundhouses and could not be moved.

Only two methods for improving the general condition of equipment existed; namely, to increase the shop facilities and forces or to use more efficiently the facilities and forces which were available. Increasing the facilities and forces under war conditions was clearly impossible; this left as the only practical means of improving equipment conditions the adoption of some plan whereby existing facilities and forces could be made to produce greater results.

The plan of considering the condition of equipment as a whole and taking steps to improve it by uniformly increasing shop hours on all railroads in the country and utilizing to their full capacity the facilities of all shops which could only be done under federal control is really what improved the condition of the locomotives and cars.

STANDARDIZATION OF EQUIPMENT

The standardization of locomotives and cars is an ideal which has long been striven for by the various organizations of railroad officials, and much has been done by them to bring about this result. Complete accomplishment has never heretofore been possible because of an absence of authority to enforce standards which might be agreed upon. This has now been accomplished by the preparation and adoption of standard designs for different types of locomotives which are suitable for all classes of service and by standardization of freight and passenger equipment.

Standardized Locomotives.—In addition to the vigorous action which had been taken to improve the condition of existing equipment, the necessity of adding to the available stock was recognized and designs were worked out for standardized locomotives and orders placed for their construction.

The locomotives were built from standardized designs for various reasons, the principal of which are as follows:

First. To reduce to a minimum the time required to prepare drawings, patterns, and dies, and thus enable deliveries to begin quicker than where separate drawings and patterns would have been necessary for each lot of locomotives allocated to a particular road.

Second. To secure quantity deliveries.

This method of construction has resulted in delivery being made at a quantity rate which could not have been approached had the locomotives been ordered to individual designs. The increase in the rate at which standardized locomotives can be turned out is clearly shown by the following comparison of two of the principal shops of the American Locomotive Company during a portion of July and August when the locomotives built were of individual design with a similar period in September and October when they were building standardized locomotives. During five weeks, beginning July 20, an average of 13⅕ locomotives per week were turned out at the Dunkirk plant, while during five weeks, beginning September 14, an average of 19⅕ locomotives per week were turned out at the same plant. For Schenectady, during the five-week period beginning July 20, an average of 8 locomotives per week were turned out, while for the corresponding period beginning September 14 an average of 13 2-5 locomotives were turned out. It will be seen that the increased production due to the standardized locomotives was about 50 per cent.

Third. It has also provided a supply of equipment, the parts of which are largely interchangeable, which is available for use anywhere in the event of congestion. This removes the necessity of carrying a large stock of repair parts peculiar to the locomotive and avoids delay which results when repair parts must be ordered from some distant owning road.

Standardized Cars.—The freight car situation was handled along the same lines as were the locomotives. In addition to the designs for freight cars, for which orders have been placed, designs have been prepared for all-steel box cars of 50 tons capacity, refrigerator cars of 30 tons capacity, general service gondola cars of 50 tons capacity, steel frame stock cars of 40 tons capacity, flat cars of 55 tons capacity, oil tank cars of 7,000 gal. capacity, oil tank cars of 8,000 gal. capacity, oil tank cars of 10,000 gal. capacity, acid tank cars of 7,000 gal. capacity, acid tank cars of 8,000 gal. capacity, and acid tank cars of 10,000 gal. capacity. While no cars have actually been built from these drawings, they are available at any time that the traffic needs show them to be desirable.

Complete plans and specifications of all steel baggage cars, in both of 60-ft. and 70-ft. lengths, have been prepared, and tentative plans prepared for 70-ft. steel coaches, and for steel passenger and mail, passenger and baggage, passenger, baggage and mail cars.

STANDARD PRACTICES

Standard practices have been established and circulars of instruction issued for mechanical work covering the following matter, which will result in more efficient and economical operation of locomotives and cars: Repairs and betterments to freight cars, painting freight cars, installing field ranges in cars, locomotive maintenance, care of journal boxes, inspection of ash pans and spark arresters, lubrication of locomotives, repairs to refrigerator cars, and superheating of locomotives.

Rules have also been promulgated for the inspection and testing by the inspection forces of the railroad companies of all stationary boilers used, which will make it possible to save the insurance premiums now paid on such boilers.

CONSOLIDATION OF MECHANICAL TERMINAL FACILITIES

Under private operation, at many points complete organizations for the maintenance of a comparatively small number of locomotives or cars were maintained side by side, which resulted in a duplication of work, heating plants, and supervising forces. Wherever a saving could be made without adversely affecting efficiency, such useless facilities were eliminated. Such consolidations have been made at 417 points and the annual saving effected thereby amounts to $2,363,535.95. Additional consolidations are now under way.

In connection with this work extensive investigations were conducted covering shop and engine-house operation, resulting in changes and improvements which have materially increased the output. For example, at one large shop the output of locomotives receiving classified repairs increased over 50 per cent, and increases ranging from 10 to 25 per cent were secured in many shops. It was also possible by rearranging the method of handling work in engine houses to release hundreds of employees that were sorely needed in other departments, and the saving effected in engine-house operation by such reduction in force, while not obtainable for all railroads, on one railroad alone amounted to $1,061,332.68 per annum.

The condition of motive power on all lines under federal control has shown a gradual improvement, and the locomotives in service are in much better condition than they were

one year ago. In addition to the improved condition of power in service there are now in white lead 1,021 locomotives in the various regions. These locomotives have received classified repairs and are being held in reserve for winter service. There are also being placed in storage for service during the winter months 150 new standardized locomotives which were recently received from the locomotive builders.

NEW DEVICES FOR LOCOMOTIVES AND CARS

On account of the vast number of new devices for use on locomotives and cars which were submitted, a comprehensive plan for handling this question was necessary. Detailed instructions were issued by circular establishing rules for the submission of such devices for the consideration of the Railroad Administration and a committee on appliances was created to conduct necessary investigations and to pass upon the value of all devices or appliances thus submitted. Up to date 692 such devices, which cover practically everything used in locomotive or car construction, have been submitted. One hundred and thirty-five of these have been examined, ten of which have been recommended for test under service conditions. These tests will proceed under the direction of the mechanical department.

EDUCATION OF RAILROAD EMPLOYEES

It has long been recognized that the service rendered by railroad employees is capable of substantial improvement by proper training of employees along industrial lines, and many railroads have in existence plans for furnishing additional training for their employees.

The Railroad Administration is in sympathy with this work and plans are being considered for establishing a system of technical training for railroad employees in connection with the Board of Vocational Education. It is also believed that this work may be profitably extended to employees who have been injured in the service to an extent that prevents them from following their usual vocation, but with proper training may fill other responsible positions.

ORGANIZATION

The work of the mechanical department, Division of Operation, has been conducted with a total force of approximately 60. Of these, 28 are considered as field men whose duties are to conduct investigations concerning shop practices and shop output and to furnish first-hand information relative to the efficiency of the work performed and the general condition of the equipment. They are also used to conduct investigations and handle disputes between shop men and railroad officials which have not reached the point where they should be referred to the Division of Labor.

The office force, in addition to handling ordinary correspondence, receives, checks and compares the reports showing the general condition of equipment, the assignment of locomotives to shops for repairs as well as the assignment of new locomotives received from the builders. It also includes the mechanical engineering staff, which checks up the designs for locomotives and cars, receives reports of failures of standardized locomotives, and corrects faulty construction. The mechanical engineering staff also acts as a clearing house for information concerning standard designs of locomotives and cars, distributes drawings and other data necessary to the proper standardization of equipment and keeps the practices up to the standard.

NEW TYPE OF LOCOMOTIVE FIREBOX

By the Introduction of Thermic Syphons the Evaporating Efficiency of the Boiler Is Materially Increased

THE Chicago, Milwaukee & St. Paul has recently completed a series of road tests of a locomotive equipped with a new type of firebox. The principal feature of the design consists of two water legs extending longitudinally from the throat of the boiler to the crown sheet. The trials were conducted with one locomotive so equipped and another of the same class with a firebox of the usual type. The results showed that the new design caused a noteworthy increase in the boiler efficiency with a corresponding decrease in the fuel consumption. The performance, as developed by the tests, is summarized in the adjoining table. Locomotive 7142 had the ordinary type of boiler, while engine 7615 had the new type of firebox.

The boiler tests conducted at Coatesville in 1912 proved conclusively that the water evaporated per square foot of heating surface in a locomotive boiler is much greater in the firebox than in the boiler tubes and flues. The maximum evaporation per square foot of tube heating surface is estimated at about 10 lb. per hr., while the corresponding figure for the firebox is 55 lb. per hr. Since these important facts have been demonstrated, the tendency in boiler design has been along the line of increased firebox heating surface. It is a difficult matter to secure more than a very limited increase in the area of the sheets in the usual design of firebox. To overcome this difficulty J. L. Nicholson of the Locomotive Firebox Company, Chicago, recently patented a new design of firebox. The salient features of this design are the water legs in the firebox, known as Nicholson Thermic Syphons.

The syphon is formed from a single sheet rolled to shape and closed by welding along the front edge. The sides are set four inches apart and joined to the crown sheet, extending from a point about 18 in. from the front edge to about 6 in. from the rear. The front edge of the water leg is parallel to the tube sheet; from the back of the crown sheet it slopes downward toward the throat of the boiler. The cross section of the leg is increased at the lower edge to form a segment of a circle six inches in diameter, which joins a 6-in. tube extending into the lower portion of the tube sheet. The syphons thus form a support for the sectional brick arch. Fig. 1 shows the side elevation and plan of the firebox on which the

GENERAL RESULTS OF TESTS

	Engine 7142	Engine 7615	Decrease. Engine 7615 Per cent
Pounds coal fired per thousand gross ton miles, actual	124.36	93.64	24.7
Pounds coal fired per thousand gross ton miles, equated	124.36	86.63	30.3
Pounds coal fired per locomotive mile	271.9	218.9	19.4
Average tonnage hauled	2,190.0	2,340.0	6.8*
Pounds of water used per thousand gross ton miles	670.72	596.22	11.1
Pounds water evaporated per pound of coal fired	5.39	6.36	18.0*
Equivalent evaporation per pound of coal fired	6.54	7.74	18.3*
Equivalent evaporation per pound of dry coal	7.28	8.60	18.1*
Equivalent evaporation per pound of combustible	8.37	10.49	25.3*
Boiler efficiency	57.65	73.75	27.92*
Front-end temperature	625 deg. F.	550 deg. F.	13.6

* Increase.

tests were made, equipped with the syphons. Fig. 2 shows another method of installing thermic syphons in locomotive fireboxes. In this case, instead of flanging the neck of the syphon out and welding it into the throat sheet, a separate diaphragm plate is used, the syphon being formed with a separate neck and expanded into the diaphragm plate, also being riveted and welded as shown. This is for the purpose of giving more flexibility to the installation, and also to enable the manufacturers, by eliminating the flanged portion of the neck and making the neck long enough to fit extreme cases, to standardize the manufacturing forms and dies.

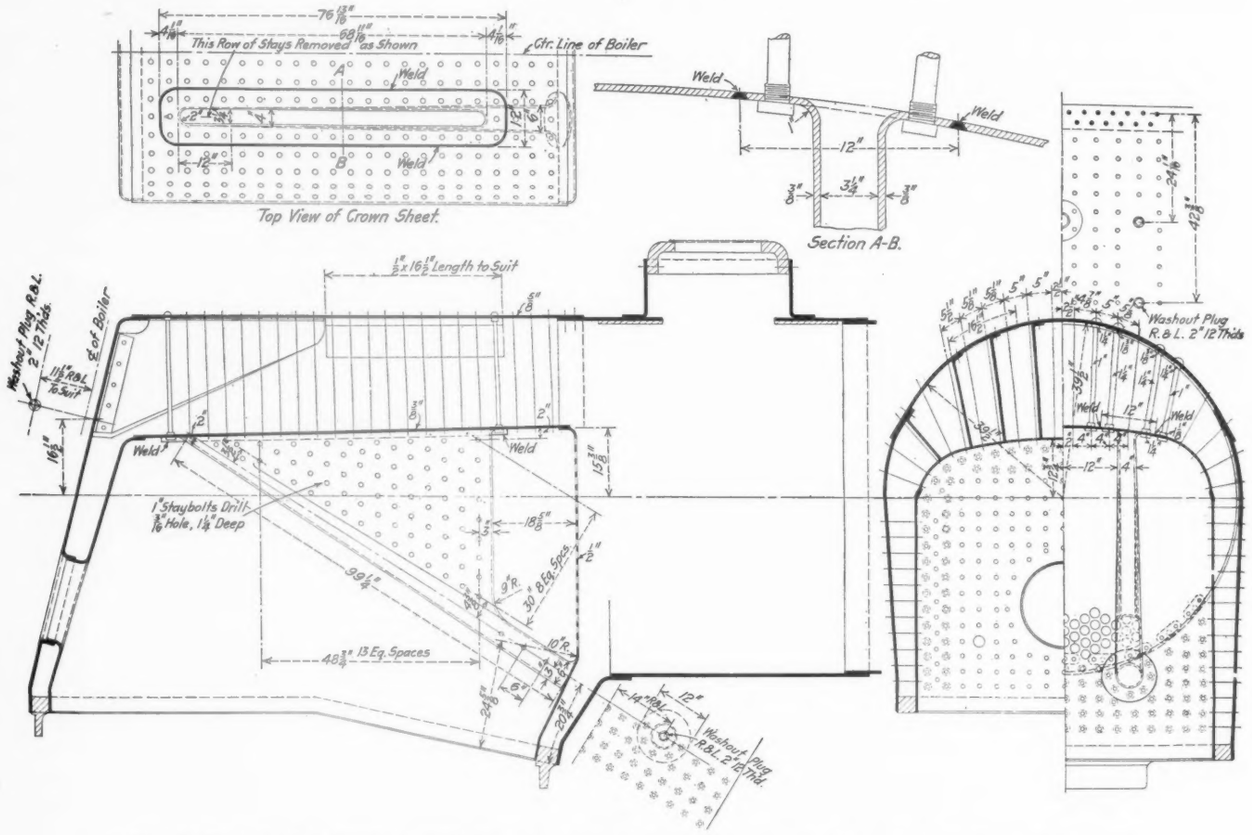

This Row of Stays Removed as Shown
Ctr. Line of Boiler
Weld
Top View of Crown Sheet
Section A-B.
Washout Plug R.&L. 2" 12 Thds
Washout Plug R.&L. 2" 12 Thds
1" Staybolts Drill 13/16 Hole, 1¼" Deep
48 3/4" 13 Eq. Spaces
99 1/4"
30" 8 Eq. Spcs.
Weld

Fig. 1—Firebox of Chicago, Milwaukee & St. Paul Locomotive Equipped with Nicholson Thermic Syphons

The locomotives tested were of the Consolidation type, using saturated steam and equipped with piston valves and Walschaert valve gear. They were alike in all respects except that the firebox of locomotive 7615 was equipped with the Nicholson Thermic Syphons supporting the brick arch, while 7142 had a brick arch supported on four 3-in. arch tubes. Both had recently received heavy repairs.

LOCOMOTIVE DATA

	Engine 7615	Engine 7142
Cylinder diameter and stroke	23 in. by 30 in.	23 in. by. 30 in.
Diameter of drivers	63 in.	63 in.
Tractive effort	42,800 lb.	42,800 lb.
Weight on drivers	190,400 lb.	189,200 lb.
Total weight of engine	216,900 lb.	215,700 lb.
Total weight of engine and tender	351,450 lb.	350,250 lb.
Boiler type	Straight. radial stay	Straight. radial stay
Boiler diameter, first course	75¾ in.	75¾ in.
Grate area	48.8 sq. ft.	48.8 sq. ft.
Tubes, number and outside diameter	414—2 in.	418—2 in.
Tube heating surface	3,143.0 sq. ft.	3,173.4 sq. ft.
Normal firebox heating surface	195.7 sq. ft.	195.7 sq. ft.
Heating surface added by arch tubes	.....	29.3 sq. ft.
Heating surface added by thermic syphons	53.0 sq. ft.	.....
Total firebox heating surface	248.7 sq. ft.	225.0 sq. ft.
Total heating surface	3,391.7 sq. ft.	3,398.4 sq. ft.
Total heating surface ÷ grate area	69.5	69.6
Firebox heating surface ÷ total heating surface, per cent	7 3	6.6
Firebox heating surface ÷ grate area	5.1	4.6

TEST CONDITIONS AND METHODS

The test runs were conducted between Milwaukee and Portage, Wis. The distance westbound was 91.8 miles and eastbound 89.1 miles. There was no attempt to control the makeup of the test trains. The tonnage was limited to what the engines could handle on the ruling grade, and trains were run as extras with whatever cars were available. Two trips eastbound and two westbound were made with each locomotive, the same engine crew being used on all the tests. A road foreman of engines acted as cab observer and all other readings were taken by employees of the test department under the direction of G. P. Kempf, engineer of tests. Weather conditions were uniform throughout the tests.

TRAIN MAKE-UP, TONNAGE AND TIME.

Eng. No.	Test No.	Cars hauled over ruling grade	Tonnage over ruling grade	Adjusted tonnage	Gross ton-miles	Time over division, hr. min.	Time in motion, hr. min.
7615	1-E	49 lds. 5 empt.	2565	2565	228,285	6 54	5 38
	2-W	29 lds. 1 empt.	2027	2166	198,853	6 59	5 14
	3-W	32 lds. 1 empt.	2055	2237	205,410	7 46	5 54
	4-E	34 lds. 35 empt.	2392	2391	212,900	6 17	5 12
	Ave.	36 lds. 10 empt.	2260	2340	211,362	6 59	5 30
7142	1-W	35 lds. 31 empt.	1976	1976	181,400	8 27	6 27
	2-E.	47 lds. 7 empt.	2315	2294	204,200	6 38	5 8
	3-W	45 lds. 0 empt.	2006	1990	182,700	7 13	5 39
	4-E	51 lds. 0 empt.	2499	2499	222,400	5 45	5 5
	Ave.	44 lds. 9 empt.	2199	2190	197,675	7 1	5 35

The engines were coaled at the chutes, no attempt being made to select the coal. The amount used was obtained by weighing the tender at the end of each run with all water emptied out of the tank. Sacked coal was used while at terminals and standing or switching on the road.

Samples were taken from the tender during each trip and were later analyzed. The average analysis was as follows:

ANALYSIS OF COAL AS FIRED

Eng. No.	Moisture	Volatile combustible	Fixed carbon	Ash	B. t. u. per pound coal
7615	10.00	35.02	38.75	16.23	10,184
7142	10.21	37.36	40.80	11.63	11,008

The coal consumption and firing rate are shown below:

COAL CONSUMPTION

Eng. No.	Test No.	Total lb. coal fired	Average lb. coal fired per hr.	Lb. coal per hr. per sq. ft. of grate	Lb. coal fired per 100-car mile	Lb. coal fired per locomotive mile	Lb. coal fired per gross 1,000 ton-miles
7615	1-E	18,400	3,262	66.84	382.8	206.7	80.60
	2-W	20,450	3,903	80.00	689.0	222.7	102.84
	3-W	20,820	3,523	72.19	513.7	226.8	101.35
	4-E	19,505	3,744	76.72	317.6	219.1	91.61
	Ave.	19,794	3,599	73.75	440.6	218.9	93.64
7142	1-W	29,450	4,558	93.40	486.0	320.8	162.12
	2-E	22,100	4,300	88.11	483.9	248.3	108.22
	3-W	25,855	4,568	93.60	638.1	281.6	141.51
	4-E	20,930	4,120	84.42	461.1	235.1	94.10
	Ave.	24,584	4,401	90.18	510.8	271.9	124.36

From an operating standpoint the boiler performance of both locomotives was satisfactory, although it was noticeable

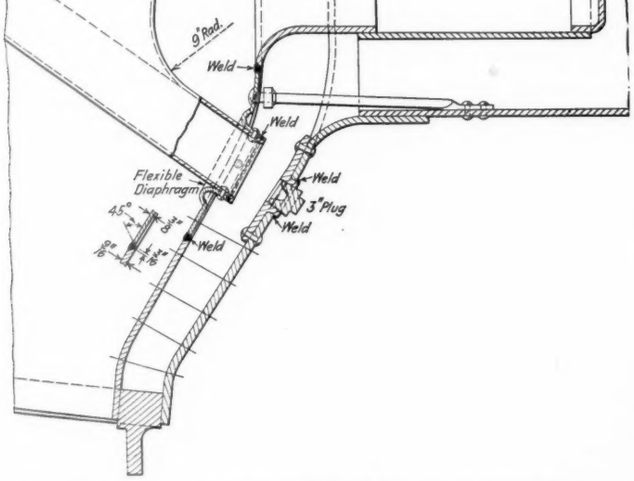


Fig. 2—An Improved Method of Applying the Thermic Syphon to the Throat

that the boiler of engine 7615 was more responsive to the demands made upon it than that of engine 7142.

It will be noted that the average boiler horsepower developed by locomotive 7615 was 807.4, as compared with 834.8 horsepower for engine 7142. This is to be accounted for by the fact that engine 7142 consumed 12.4 per cent more water per thousand gross ton miles. Neither of the locomotives was forced to the limit of the capacity of the boiler. Engine 7615 developed a maximum boiler horsepower of 1,015 on the grade from Milwaukee to Brookfield. This is at the rate of 10.62 lb. equivalent evaporation per square foot of heating surface per hour.

Both locomotives had double exhaust nozzles with 3½-in. tips at the time these readings were taken. On the last round trip with engine 7615 the tips were enlarged to 3-11/16 in. diameter, which reduced the vacuum somewhat. The front end temperatures were obtained by means of a Hoskins pyrometer. It is thought that owing to an improper adjustment of the recorder the temperatures recorded for engine 7142 are too low.

No analysis was made of the front end gases, so it is impossible to tell exactly what changes in combustion conditions were brought about by the changes in the firebox. The reduction in the coal consumption, the increase in the evaporation and the marked absence of smoke indicates that the syphons tend to improve combustion conditions by breaking up the stream of gases and securing a better mixture of the combustible gases and the air.

In considering the increased boiler efficiency secured by the use of the Nicholson Thermic Syphons it should be noted that engine 7615 was working at a lower rate of evaporation

BOILER PERFORMANCE—COAL AND APPARENT EVAPORATION

Eng. No.	Test No.	Lb. coal fired per hour	Lb. water evap'd	Lb. water evap'd per lb. coal	Lb. water evap'd per sq. ft. heat. surf.	Temp. feed water	Average boiler pressure	Factor of evap.
7615	1-E	3,262	21,782	6.68	6.42	49 Deg.	198.3	1.2187
	2-W	3,903	23,553	6.04	6.94	52 Deg.	199.2	1.2149
	3-W	3,523	22,825	6.48	6.73	52 Deg.	198.9	1.2149
	4-E	3,744	23,589	6.30	6.95	51 Deg.	198.4	1.2159
	Ave.	3,599	22,912	6.36	6.75	51 Deg.	198.7	1.2159
7142	1-W	4,558	23,707	5.20	6.97	50 Deg.	198.8	1.2170
	2-E	4,300	24,554	5.71	7.22	54 Deg.	198.3	1.2129
	3-W	4,568	23,394	5.12	6.88	58 Deg.	196.6	1.2086
	4-E	4,120	23,338	5.66	6.88	52 Deg.	197.6	1.2149
	Ave.	4,401	23,728	5.39	6.98	53 Deg.	197.9	1.2139

BOILER PERFORMANCE—EQUIV. EVAP. HORSE POWER AND EFFICIENCY

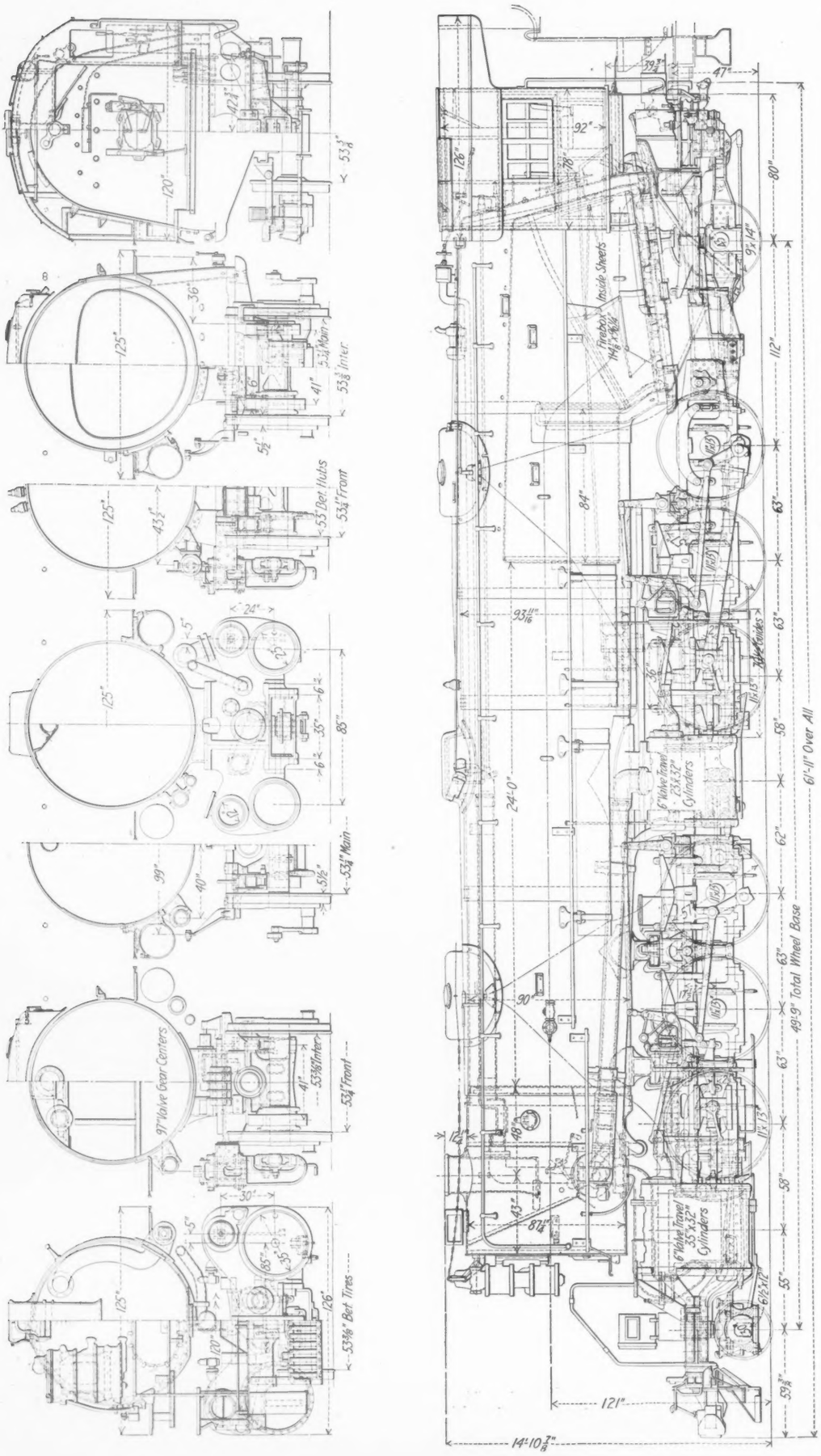
Eng. No.	Test No.	Equivalent-evaporation—from and at 212 Deg. F. lb. Per hour	Per hr. per sq. ft. heat. surf.	Per lb. of coal as fired	Per lb. of dry coal	Per lb. of combustible	Boiler hp.	Boiler efficiency
7615	1-E	26,546	7.82	8.14	9.04	9.42	769.4	67.00
	2-W	28,615	8.43	7.34	8.14	10.22	826.5	73.63
	3-W	27,730	8.16	7.87	8.74	11.09	803.7	77.96
	4-E	28,682	8.45	7.66	8.51	10.77	831.3	77.26
	Ave.	27,858	8.21	7.74	8.60	10.49	807.4	73.75
7142	1-W	28,851	8.48	6.33	7.10	8.26	836.2	58.00
	2-E	29,781	8.76	6.93	7.35	8.95	863.2	61.35
	3-W	28,274	8.31	6.19	6.96	7.85	819.5	53.89
	4-E	28,353	8.34	6.88	7.59	8.56	821.8	58.10
	Ave.	28,803	8.47	6.54	7.28	8.37	834.8	57.65

DRAFT AND FRONT END TEMPERATURE

Eng. No.	Test No.	Lb. coal fired per hour	Lb. coal fired per sq. ft. grate per hour	Draft—Inches of water: Front end	Firebox	Ash pan	Front end Temp. Deg.
7615	1-E	3,262	66.84	5.2	1.67	.27	520
	2-W	3,903	80.00	5.3	1.66	.29	536
	Ave.	3,582	73.42	5.25	1.66	.28	528
7142	1-W	4,558	93.40	5.3	1.56	.22	610
	2-E	4,300	88.11	5.0	1.27	.17	589
	Ave.	4,429	90.15	5.15	1.41	.195	599

than engine 7142 and also at a lower rate of combustion, which made a favorable condition for obtaining higher boiler efficiency. In this connection, however, it should not be overlooked that this was not due to operating conditions favoring engine 7615, as the average tonnage hauled by this locomotive was 6.8 per cent greater than that hauled by engine 7142. Making due allowance for the favorable evaporation and combustion rates, there remains a gain in economy which cannot be attributed entirely to the increased firebox heating surface. There is evidently a further saving due to the increase in the radiating surface in the firebox, to the more intimate mingling of the combustible gases with air in the firebox and to the more rapid circulation through the boiler. It is estimated that the rate of flow through the syphons is so fast that all the water in the boiler passes through them every five minutes. Such rapid circulation will cause the water to remain at more nearly uniform temperature throughout the boiler. This should result in a decrease in the boiler troubles due to unequal expansion and contraction.

The cost of application of the Nicholson Thermic Syphons is low, and it is anticipated that the maintenance charges will be negligible compared with the savings effected. The syphon requires no more attention than any other part of the firebox and when properly applied is practically fool-proof and accident-proof. The first installation has been in service for four months and has given no trouble from mud or scale. The rapid circulation has kept the syphons clean and has apparently resulted in throwing the mud and scale into the back water leg, where it can easily be removed. Up to the present time there has been no evidence of scale in the syphons, and no leak or trouble of any nature has developed at the seams or stays. The C. M. & St. P. is now planning to install the syphons on several additional locomotives.



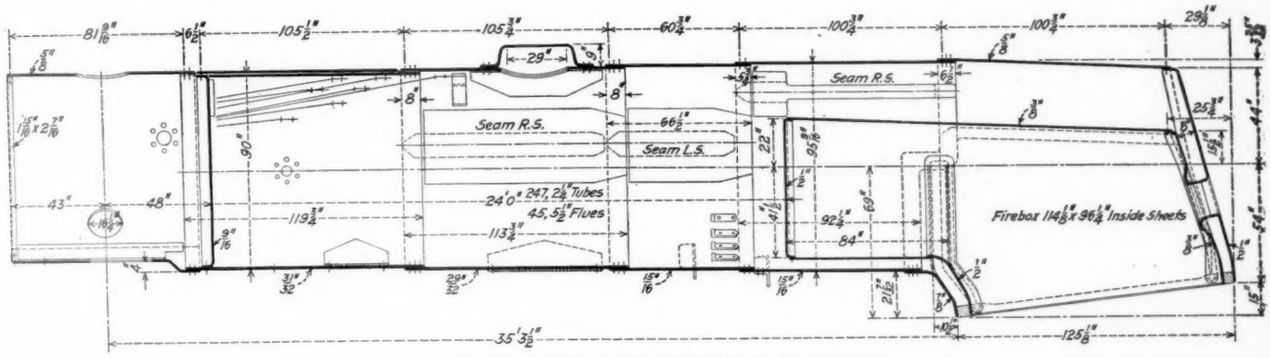
Elevation and Sections of the United States Railroad Administration Standard 2-6-6-2 Type Locomotive

STANDARD 2-6-6-2 TYPE LOCOMOTIVE

Weights: Total 448,000 lb., Drivers 358,000 lb.;
Tractive Effort Compound 80,000 lb., Simple 96,000 lb.

THE first of the standard Mallet type locomotives designed by the United States Railroad Administration has recently been turned out by the Schenectady works of the American Locomotive Company, for delivery to the Chesapeake & Ohio. The locomotive is of the 2-6-6-2 type, the lighter of the two standard Mallet types, and orders were placed for 30 of these locomotives.

The locomotive has a weight on drivers of 358,000 lb., 2,000 lb. less than the maximum permissible within the axle load limit of 60,000 lb. The cylinders are 23 in. and 35 in. in diameter by 32 in. stroke and the locomotive is designed



Boiler for the Standard 2-6-6-2 Type Locomotive

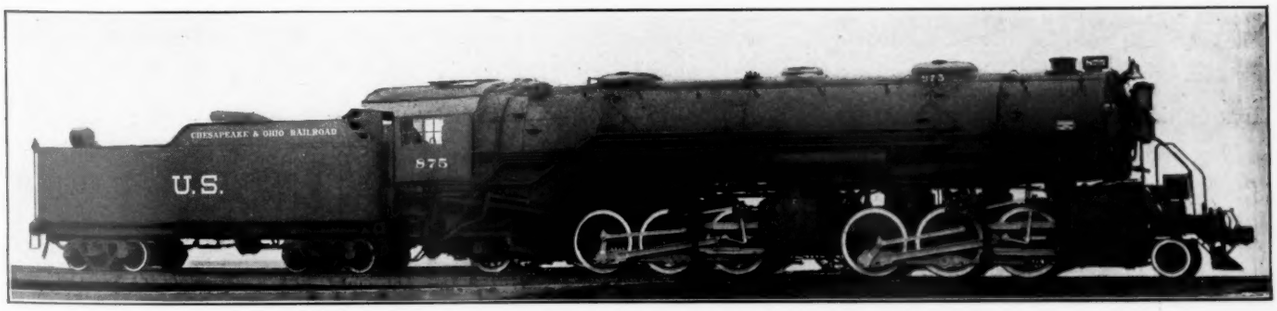
to deliver a tractive effort of 96,000 lb. simple and 80,000 lb. compound. In the table will be found a comparison of the principal dimensions and data for a number of Mallet locomotives of the 2-6-6-2 wheel arrangement, of which the standard locomotive is the heaviest both on drivers and in total weight.

The boiler has an outside diameter at the first ring of 90 in., increasing to 95 9/16 in. at the fourth ring just forward of the firebox. The dome is located on the second ring from the front and is 9 in. high.

The firebox has a combustion chamber extending forward into the barrel of the boiler 84 in. from the throat sheet, making the tubes 24 ft. long. It is fitted with a Security brick arch carried on five arch tubes and is fired by a Standard stoker. The fire door is of the Shoemaker power operated type and the grates are operated by Franklin power grate shakers. The boiler is fitted with the Locomotive Superheater Company's Type A superheater with 45 units.

In general the detail design of the frames follows that of all the other standard type locomotives which have been built. The top rails for both high and low pressure units are 6 in. wide, with a maximum thickness of 5 in. over the pedestals and a minimum thickness of 4½ in. The lower rails have a maximum and minimum thickness of 3½ in. and 3 in. respectively. The high pressure frames are designed with splice joints at the rear for attachment to a Commonwealth frame cradle which includes in one casting the frames, rear deck plate and trailer equalizer fulcrums. The high pressure cylinders are supported on a single front rail which is cast integral with the main frames.

The low pressure frames are designed to receive the articulation joint, which is of the Baldwin universal type, hinged for movement about a horizontal axis transverse to the center line of the locomotive and provided with a ball joint pin connection at the high pressure unit end. The low pressure cylinders are supported by double rails, both of which are bolted to the main frame. The frames of both units are spaced 41 in. from center to center, while the cylinders have a spread of 85 in. Owing to the size of the low pressure cylinders the face of the lower rail bolting flange is only 20½ in. from the center line of the locomotive, thus requiring an offset in the front frame rail. This is provided by bolting the front rail to the inside face of the lower rail extension of the main frame and reducing the lateral thickness of this section to 3 in. where it is joined under the cylinder to the front rail. The section of the extension under the cylinders is 11 in. deep, while that of the front rail has a vertical thickness of 7 in. The upper front rail is bolted and keyed to the top of the main frame over the front pedestal. The section of the main frame here is 13 in. deep with horizontal slots for the splice bolt nuts over the pedestal.



The Railroad Administration Standard 2-6-6-2 Type Locomotive

The cylinders and valve chambers throughout are bushed with Hunt-Spiller gun iron. In the design of the high pres-

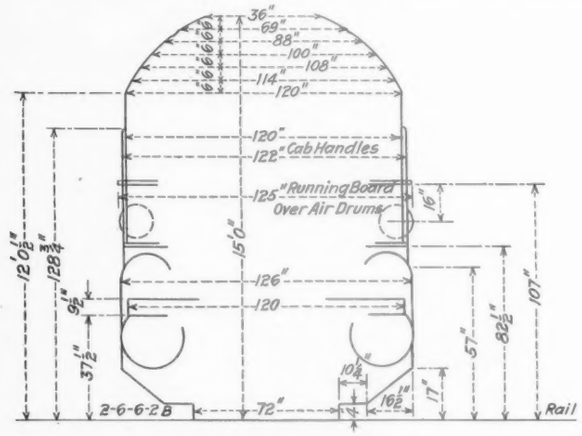
sure cylinders is incorporated the Mellin intercepting valve which completely controls the admission of steam, either exhaust from the high pressure cylinders or steam direct from the boiler, to the low pressure receiver pipe. Piston valves

COMPARISON OF RECENT MALLET LOCOMOTIVES OF THE 2-6-6-2 TYPE

Name of road	U.S. Std.	B.R. & P.	N. & W.	C. & O.
Year built	1919	1914	1912	1911
Builder	American	American	American	American
Tractive effort, lb.	80,000	80,000	72,800	72,800
Total weight, lb.	448,000	429,000	405,000	400,000
Weight on drivers, lb.	358,000	355,000	337,000	337,500
Diameter drivers, in.	57	57	56	56
Cylinder diameter and stroke, in.	23 & 35 x 32	23½ & 37 x 32	22 & 35 x 32	22 & 35 x 32
Steam pressure, lb. per sq. in.	225	200	200	200
Heating surface, total evap., sq. ft.	5,443	4,935	5,003	5,064
Heating surface, equivalent,* sq. ft.	7,381	6,473	6,485	6,430
Grate area, sq. ft.	76.3	72.2	72.2	72.2
Tractive effort × dia. drivers ÷ equivalent heating surface*	617.8	704.5	628.6	634.0
Firebox heating surface ÷ equivalent heating surface,* per cent	5.6	6.0	5.3	6.1

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

are employed with both the high and low pressure cylinders. These valves are 12 in. in diameter and have a maximum travel of 6 in. The valves for the low pressure cylinders are

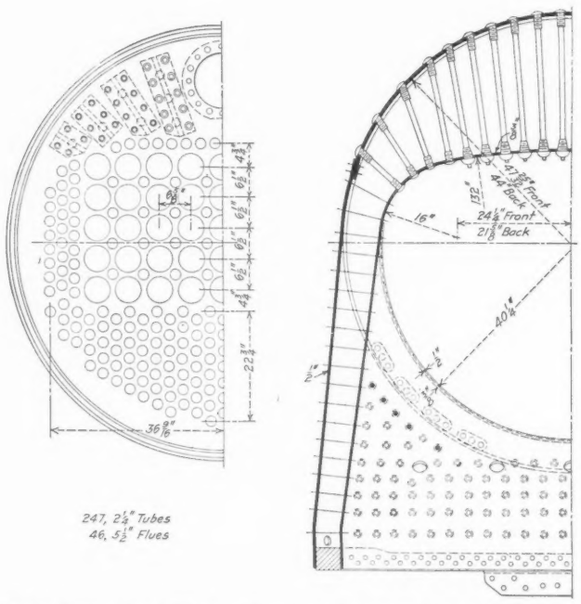


Clearance Diagram for the Standard 2-6-6-2 Type Locomotive

double ported while those for the high pressure cylinders are the same as are used on the 0-6-0 type switchers.

The high pressure piston specifications call for either rolled or cast steel of dished section, while for the low pressure pistons the center of which has a diameter of 30¾ in., exclusive of the bull ring, cast steel only is specified. Hunt-Spiller gun iron bull rings and packing rings are used on both high and low pressure pistons. The design of the crossheads is the same in detail as that employed on all previously built standard locomotives, and is interchangeable with that on the 0-6-0 switchers. Paxton-Mitchell packing is fitted both on the valve stems and piston rods. Steam distribution is controlled by the Baker valve gear and the Chambers back head type throttle. The locomotive is fitted with a Lewis power reverse gear.

The driving journals throughout have a diameter of 11 in. and are 13 in. long. The driving boxes are interchangeable on all journals, except that the crown brass for the main journals is finished with a clearance of 1/100 in. instead of 1/32 in. The same driving box is also used on the heavy Mountain type locomotive, with the exception of the main journals, and on the main journals of the

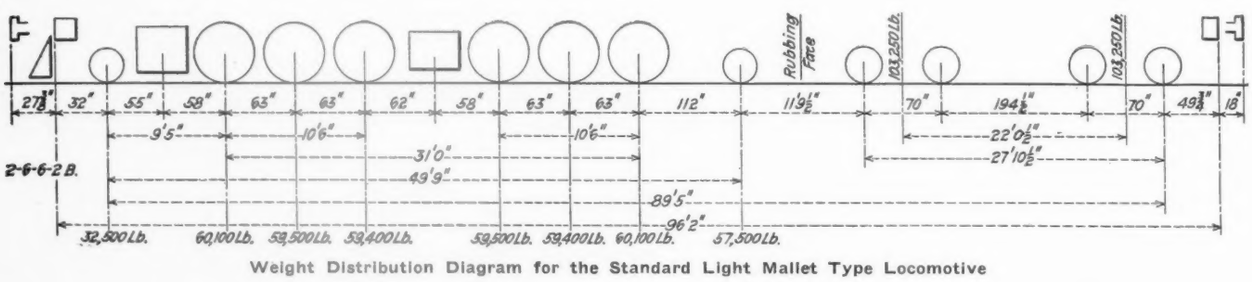


Tube Layout and Firebox Section—Standard Light Mallet Type Locomotive

light Mikado type locomotive. The engine truck is of the constant resistance type and the trailer truck is of the Cole-Scoville type.

The tender tank has a water capacity of 12,000 gallons and a coal capacity of 16 tons. It is carried on a Commonwealth cast steel frame, and is one of the three standard types which have been designed to meet the requirements of all of the standard locomotives. The trucks have cast steel side frames and are of a design which is used on all the standard freight locomotives. The Unit Safety drawbar and Radial buffers are used between the engine and tender.

Among the specialties with which these locomotives are equipped are four Coale three-inch open safety valves, No. 13 Nathan non-lifting injectors, Nathan bull's-eye lubricators, Ashton steam gages, Okadee flanged blow-off cocks and Barco flexible pipe joints.



Weight Distribution Diagram for the Standard Light Mallet Type Locomotive

On the diagrams, prepared by F. P. Pfahler, chief mechanical engineer, Division of Operation of the Railroad Admin-

istration, will be found the clearances and actual wheel load distribution for these locomotives. Other dimensions and data are as follows:

General Data

Gage	4 ft., 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort, compound	80,000 lb
Tractive effort, simple	96,000 lb.
Weight in working order	448,000 lb.
Weight on drivers	358,000 lb.
Weight on leading truck	32,500 lb.
Weight on trailing truck	57,500 lb.
Weight of engine and tender in working order	654,000 lb.
Wheel base, driving	31 ft.
Wheel base, rigid	10 ft. 6 in.
Wheel base, total	49 ft. 9 in.
Wheel base, engine and tender	89 ft. 5 in.

Ratios

Weight on drivers ÷ tractive effort, simple	3.7
Total weight ÷ tractive effort, simple	4.7
Tractive effort, compound × diam. drivers ÷ equivalent heating surface*	617.8
Equivalent heating surface* ÷ grate area	100.3
Firebox heating surface ÷ equivalent heating surface,* per cent	5.6
Weight on drivers ÷ equivalent heating surface*	48.5
Total weight ÷ equivalent heating surface*	60.7
Volume equivalent simple cylinders	21.7 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	340.5
Grate area ÷ vol. cylinders	3.4

Cylinders

Kind	Compound
Diameter and stroke	23 in. and 35 in. by 32 in.

Valves

Kind	Piston
Diameter	12 in.
Greatest travel	6 in.
Outside lap	1 in.
Inside clearance	H. P., ¼ in.; L. P., 3/8 in.
Lead in full gear	1/8 in.

Wheels.

Driving, diameter over tires	57 in.
Driving journals, main, diameter and length	11 in. by 13 in.
Driving journals, others, diameter and length	11 in. by 13 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6½ in. by 12 in.
Trailing truck wheels, diameter	43 in.
Trailing truck, journals	9 in. by 14 in.

Boiler

Style	Straight top
Working pressure	225 lb. per sq. in.
Outside diameter of first ring	90 in.
Firebox, length and width	114⅛ in. by 96¼ in.
Firebox plates, thickness	Sides, back and crown, 3/8 in.; tube, ½ in.
Firebox, water space	Sides and back, 5 in.; front, 6 in.
Tubes, number and outside diameter	247—2¼ in.
Flues, number and outside diameter	45—5½ in.
Tubes and flues, length	24 ft.
Heating surface, tubes	3,478 sq. ft.
Heating surface, flues	1,549 sq. ft.
Heating surface, firebox and arch tubes	416 sq. ft.
Heating surface, total	5,443 sq. ft.
Superheater heating surface	1,292 sq. ft.
Equivalent heating surface*	7,381 sq. ft.
Grate area	76.3 sq. ft.

Tender

Tank	Water bottom
Frame	Cast steel
Weight	206,500 lb.
Wheels, diameter	33 in.
Water capacity	12,000 gal.
Coal capacity	16 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

ENGINE FAILURES—CAUSES AND REMEDIES*

It has been said that the engine failure reports form one of the best barometers of the efficiency of the mechanical department, and this is indeed the case where all detentions and reported failures are carefully investigated *before* they are recorded. Where the engine failures charged depend, however, on the reports of conductors or on interpretations of the rules by the despatcher's or trainmaster's clerk, the accuracy of the charge is often open to question.

An engine failure on the line of road is an expensive proposition, more far reaching in its effects on the movement of trains than is generally believed by mechanical men who have had no road experience, often so upsetting the despatcher's pre-arranged schedule that we cannot be surprised if he loses his temper and feels like charging every delay, regardless of cause, as an engine failure.

*Abstract of a committee report presented at the 1918 convention of the Traveling Engineers' Association.

DEFINITION OF WHAT CONSTITUTES AN ENGINE FAILURE

1. All delays waiting for an engine at an initial terminal, except in cases where an engine must be turned and does not arrive in time to be cared for before leaving time.

2. All delays on account of engines breaking down, running hot, not steaming well, or having to reduce tonnage on account of defective engine, making a delay at a terminal, a meeting point, a junction connection, or to other traffic.

DELAYS THAT SHOULD NOT BE CONSIDERED AN ENGINE FAILURE

1. Do not report cases where engines lose time and afterwards regain it without delay to connections or other traffic.

2. In cases where a passenger or scheduled freight train is delayed from other causes, and an engine (having a defect) makes up more time than she loses on her own account, should not be called an engine failure.

3. Do not report delays to passenger trains when they are less than five minutes late at terminals or junction points.

4. Do not report delays to scheduled freight trains when less than 20 minutes late at terminals or junctions.

5. Do not report delays when an engine is given excess of tonnage and stalls on a hill, provided the engine is working and steaming well.

6. Do not report delays on extra dead freight trains if the run is made in less hours than the miles divided by ten.

7. Do not report engine failures on account of engines steaming poorly, or flues leaking, on any run where the engine has been delayed on side-tracks other than by defects of engine, or on the road an unreasonable length of time—say, 15 hr. or more per 100 miles.

8. Do not report an engine failure for reasonable delays in cleaning fires and ash-pans on the road.

9. Do not report failures against engines that are coming from outside points to the shops for repairs.

10. Do not report cases where an engine is held in the roundhouse for needed repairs and called for by the operating department, they being informed that the engine will not be ready until a stated time. Failure to provide that engine before the stated time should not be called an engine failure.

11. Do not report broken draft rigging on engines and tenders caused by air being set on train, account of bursted hose or breaking in two.

12. Do not report delays to fast schedule trains when the weather conditions are such that it is impossible to make the time, provided that the engine is working and steaming well.

13. Do not report delays when an engine gets out of coal and water, caused by being held between coal and water stations an unreasonable length of time.

If rule No. 2 is correctly interpreted there is no need for the 13 qualifying rules. However, if an engine apparently fails on the line of road, it is charged as an engine failure, although the engine may be in perfect condition and the delay due entirely to other causes, such as mishandling on the part of the crew, either engineer or fireman, excessive tonnage, weather conditions, or any of a hundred possible causes, any of which may result in a poor engine performance and for which the engine or its condition is least of all responsible.

The true cause of the poor performance should be determined by a full investigation, which, however, may not be possible immediately and, consequently, when determined several days may have elapsed before the cancellation of the charge is requested. This being the case, it appears to this committee, in justice to the mechanical department, it would be much more equitable were all doubtful cases simply shown as delays on the "morning report" and these delays then promptly investigated and where the failure is established it be so reported on a subsequent report, or else a monthly report compiled, showing all failures and delays.

Any criticism to be of value must be constructive; therefore, as a first step toward the elimination of engine failures, we

would recommend a closer relationship between all departments of a railroad, "get-together" meetings about once a month where engine and train performance can be freely discussed and wrong practices corrected.

We would also recommend that the mechanical department be kept advised as far ahead as possible of any power requirements, so that fitting preparation can be made, as where no such system obtains the roundhouse foreman will sometimes take a chance when pressed for power and let an engine go on the assumption that perhaps it can make just one more trip.

A check of the various engine failures extending over a period of two years, shows as follows:

Failures in Two Years Per 1,000 Miles of Road

Air brake and piping	15
Ash pan and rigging	5
Axle, driving, broken	2
Brake rigging	3
Boiler studs	1
Boiler checks	4
Blow-off cocks	3
By-pass valves	2
Cylinder packing	9
Cross-heads	2
Cylinder heads broken	5
Crank pins broken	3
Draft gear	4
Flues leaking	24
Frames broken	7
Follower bolts	1
Foaming	1
Grates and rigging	4
Guides and guide bolts	5
Head lights	6
Hose, air and water	3
Injectors	1
Journals, hot	21
Lubricator	1
Pins, hot	14
Piston rods broken	6
Relief valve	1
Stokers	12
Springs and rigging	6
Tires slipped	31
Terminal delays	39
Valve gear—Stephenson	17
Valve gear—Walschaert	16
Wrist pins and nuts	3
No steam	11
Man failures	13
Total	329

In the list above presented is it not clearly established that if the provisions of the Federal Inspection Laws were fully complied with in letter and spirit at least half of these failures would have been eliminated, and by the same token would it not appear that one of the logical remedies for engine failures is a strict compliance with the inspection rules? An analysis of the above reported failures shows that at least 50 per cent of the mechanical failures should have been preventable and practically all of the man failures likewise.

In this report we will consider only the principal failures, such as are common to all railroads.

Air Brakes and Piping.—An air compressor should be overhauled periodically just the same as a locomotive, but, unfortunately, as the moving parts are hidden and the compressor capacity is usually in excess of average requirements, they are frequently allowed to run until failure results. Some railroads make a practice of numbering air compressors and keeping a mileage record of them, and when the allotted mileage has been made, they are overhauled. The pipes and connections to the air compressor become strained, due to the variations in expansion, the universal use of flexible joints would go far toward preventing pipe failures.

Hot Journals.—Periodical and regular inspection is the logical remedy.

Hot Pins.—The present systems of crank pin lubrication are crude, to say the least. Poor fitting bearings are, of course, responsible for many hot pins, but irregular lubrication is responsible for much more. Heavy grease is a makeshift, not an efficient lubricant.

Cylinder Packing.—With the advent of superheater engines, such failures are becoming more common. Regular periodical inspection, together with the application of a reliable drifting valve, would go far toward reducing this.

Flues Leaking.—This is often due as much to the manner in which the engine is fired, pumped or handled as to any mechanical defect, and much can be done by education and co-operation of the enginemen. Flues should be inspected each trip on arrival and if their condition is such as to make it doubtful if the engine can make a successful trip they should be removed. One road failure will often cost more than the renewal of an entire set of flues.

Broken Rods and Straps.—Rods and rod straps seldom break at once. It would, therefore, appear that closer inspection for cracks would be advisable. It is found that rod, piston, crank pin and axle failures on old locomotives which have been modernized are becoming more frequent, and investigations lead to the belief that some of the failures are due to increasing the tractive effort of the old locomotives without correspondingly increasing the strength of the parts that must stand the increased strain. Fully 80 per cent of the side rods break in the jaws at the knuckle joint connection. This would indicate that our knuckle joints are fitted too snug laterally so that when lateral wear develops in the driving wheels it sets up stresses in rod jaws. By allowing sufficient play in the jaws to compensate for lateral wear in drivers, much of this stress would be relieved.

Stokers.—Ninety per cent of the so-called stoker failures can be traced right back to neglect on the part of firemen and are due either to lack of proper care in lubrication, to excessive wetting down of coal, or to allowing the hopper or feed trough to get clogged. Education and discipline is all that is needed here.

Slipped Tires.—During the past two years 31 failures due to slipped tires were reported. Of these 18 were man failures, pure and simple, and caused by excessive and unnecessary braking. There is room for more education, especially on E. T. equipment. All enginemen do not realize that the straight air will creep on if the automatic valve is not properly handled, and yet, even if ignorant, there is no excuse, as the small gage will always tell what is going on, if consulted.

Terminal Delays.—Failures are charged for any delay to engines at terminals, regardless of cause; therefore, the only logical way apparently of correcting them is to adopt the method in vogue on some railroads, viz.: make a double inspection, one on arrival and the other prior to departure. This, to many, may appear unnecessary, but the fact remains that all men will overlook something sometimes.

Walschaert Valve Gears.—All of the failures charged were due to poor design in so far as the fastening of the union link arm is concerned, and should not be classed as defects to the gear itself.

Steam Failures.—In nearly every instance, the alleged failures were due to inexperienced firemen, and this brings up a subject on which volumes could be written, viz.: the proper training of enginemen, a subject so broad, however, that it should not be handled in this report. In the same class can be placed the man failures, all of which though charged against the engine, were due entirely to inexperience or ignorance on the part of the men.

Let it be understood that this report is not intended to reflect discredit on the enginemen when speaking of ignorance or inexperience, but rather on the methods in use on too many of our railroads. New devices are continually being applied and too often men are expected to familiarize themselves with these with no other instructions than that contained in descriptive pamphlets. One ounce of ocular demonstration is worth a pound of reading in such cases. We feel that all new methods or devices should be thoroughly explained and demonstrated to the men whose duty it is to operate or work with them, before we can place ourselves in position to criticise. Every roundhouse where repairs are made can be fitted up with instruction rooms, containing charts or models or both, and certain hours or dates can be set when instruction will be given. Then if the men do not take these opportunities, action can be taken in case of man failure.

RAILROAD ADMINISTRATION NEWS

Walker D. Hines Appointed New Director General; News of Interest to the Mechanical Department

THE appointment of Walker D. Hines, assistant director general of railroads and formerly chairman and general counsel of the Atchison, Topeka & Santa Fe, to the director generalship was announced by Mr. McAdoo at Los Angeles on January 11, and Mr. Hines entered upon the duties of his office immediately.

In announcing Mr. Hines' appointment Mr. McAdoo said: "Mr. Hines has been my assistant at Washington since the beginning of government control and has a thorough knowledge of the organization and administration of the railroads under federal control as well as the fundamental problem involved in the railroad situation. His ability and experience admirably fit him for the great trust and responsibility with which the President has honored him. Aside from his obvious qualifications Mr. Hines is in full sympathy with the policies which have guided the Railroad Administration and with the views of the President on the railroad question. I am sure that Mr. Hines will have the hearty support of the fine army of railroad officers and employees and I can ask nothing better for him than that they shall give him and the country the same loyal and effective service they rendered during my term as director general."

Walker D. Hines

It was announced that Mr. Hines will receive the same salary, $25,000 a year, which he has received during the past year as assistant to Mr. McAdoo and which was fixed for the directors of the departmental divisions of the Railroad Administration. In accepting the office Mr. Hines stated that he will carry forward the policies followed by Mr. McAdoo during the past year. He issued the following statement to railroad officers and employees:

"The President has appointed me director general of railroads, effective at once. I wish my first official act as director general of railroads to be this statement to officers and employees:

"Having been a part of Mr. McAdoo's organization from its first day, his policies are my policies and I intend to carry them out and to do so through the existing railroad organizations of the Railroad Administration.

"The responsibilities of the work cannot be exaggerated and there can be no success in it without your confidence and support.

"I shall gain and justify your confidence by prompt and fair treatment, but until you get a chance to know me and judge me by my works I want you to take me on faith and from the very first day help me to give the government the best possible service and the people the best possible transportation. You and I have been fellow workers in the hard work of the past year and I ask you to join me in giving the public even in time of peace the valiant and faithful service that you gave so heartily in time of war."

Mr. Hines was born February 2, 1870, at Russellville, Ky. He entered railway service in 1893 as assistant attorney of the Louisville & Nashville. He later became first vice-president of the road, following which he entered general law practice. In 1906 he was appointed general counsel of the Atchison, Topeka & Santa Fe and became chairman of the executive committee of that road in 1908.

As there is little probability that Congress will approve the five-year extension plan which has been strongly advocated by both Mr. Hines and Mr. McAdoo, it is believed in Washington that Mr. Hines' tenure of office will be short and that one of his principal duties will be to wind up the affairs of the Railroad Administration.

One of the first official acts of the new director general was the appointment of W. T. Tyler as director of the Division of Operation to succeed Carl R. Gray. Mr. Tyler entered railway service with the Wisconsin Central in 1883 as messenger. He has followed railroading consistently since that time, having been assistant to the vice-president in charge of operation of the Northern Pacific before he went to Washington last January as Mr. Gray's senior assistant.

During the month Thomas C. Powell, recently manager of inland traffic of the War Industries Board and formerly vice-president of the Cincinnati, New Orleans & Texas Pacific and the Alabama Great Southern, was appointed director of the Division of Capital Expenditures, succeeding Judge Robert S. Lovett. Mr. Powell was born in 1865 and since 1884 has been engaged in railroad service on lines connected with the Southern Railway System, starting as mail clerk for the Cincinnati, New Orleans & Texas Pacific.

INTERPRETATION OF WAGE ORDER

Director General McAdoo has issued the following interpretation No. 8 of General Order No. 27:

As there seems to have been a misunderstanding on some railroads as to the application of General Order No. 27, the said order is hereby interpreted to apply to all persons in the employment of the railroads earning less than $250 per month in December, 1915. Where such persons have not

been granted the increases provided for in General Order No. 27 such increases will be made applicable retroactive to January 1, 1918, and until superseded by supplements thereto.

LOCOMOTIVE SPECIALTIES

The Central Advisory Purchasing Committee of the Railroad Administration has decided on the specialties to be used on the orders placed some time ago with the American Locomotive Company and the Lima Locomotive Works for 600 locomotives for 1919 delivery. Practically the same specialties will be used that were authorized for the locomotives ordered for 1918.

STANDARD LOCOMOTIVES DELIVERED TO JANUARY 18, 1919

Alabama & W. Point & Western Ry. of Ala.	2		0-8-0	American
Atlantic Coast Line	5		0-6-0	American
Baltimore & Ohio	69	Light	2-8-2	Baldwin
Belt Railway of Chicago	5	Light	2-10-2	American
Boston & Albany	10	Light	2-10-2	American
Central of New Jersey	10		0-6-0	American
	10	Heavy	2-8-2	American
Chesapeake & Ohio	4		2-6-6-2	American
Chicago & Alton	10	Light	2-8-2	American
Chicago Junction	14		0-6-0	American
Chicago & Eastern Illinois	15	Light	2-8-2	American
Chicago Great Western	10	Light	2-8-2	Baldwin
Chicago, Indianapolis & Louisville	5	Light	2-8-2	American
Chicago, Milwaukee & St. Paul	50	Heavy	2-8-2	American
Cleveland, Cincinnati, Chicago & St. Louis	25	Light	2-8-2	Baldwin
Duluth, Missabe & Northern	7	Light	2-10-2	American
El Paso & Southwestern	5	Heavy	2-8-2	American
Erie	16		0-8-0	American
	15	Heavy	2-8-2	American
Grand Trunk Western	16	Light	2-8-2	American
Grand Trunk	24	Light	2-8-2	American
Lake Erie & Western	15	Light	2-8-2	Baldwin
Lehigh & Hudson River	4	Light	2-8-2	Baldwin
Louisville & Nashville	20	Heavy	2-8-2	American
Michigan Central	20	Light	2-8-2	American
Mobile & Ohio	4		0-6-0	American
Nashville, Chattanooga & St. Louis	10	Light	2-8-2	American
New York Central	45	Light	2-8-2	Lima
	25		0-8-0	American
	50	Light	2-8-2	American
New York, Chicago & St. Louis	10	Light	2-8-2	American
Oregon Short Line	19	Light	2-8-2	American
Pennsylvania Lines West	20		0-6-0	American
Pittsburgh & West Virginia	3	Light	2-8-2	Baldwin
	2		0-6-0	American
Pittsburgh, McKeesport & Youghiogheny	10	Heavy	2-8-2	American
Rutland	2		0-8-0	American
	6	Light	2-8-2	American
Seaboard Air Line	10		0-6-0	American
	10	Light	2-8-2	American
Southern	20		0-8-0	American
	25	Light	2-8-2	American
	50	Light	2-10-2	American
Terminal Railroad of St. Louis	10		0-6-0	American
Texas & Pacific	11	Light	2-8-2	American
Toledo & Ohio Central	5		0-8-0	American
	15	Light	2-8-2	American
Union Pacific	10		0-6-0	American
	20	Light	2-8-2	American
Wabash	20	Light	2-8-2	American
Western Pacific	5	Light	2-8-2	Baldwin
Wheeling & Lake Erie	5		0-8-0	American
	10	Heavy	2-8-2	American

Total—		
Six-wheel switching, American		85
Eight-wheel switching, American		75
Light Mikado, American	286	
Baldwin	131	
Lima	45	
		462
Heavy Mikado, American		120
Light Santa Fe, American		72
2-6-6-2 Mallet, American		4
Total to January 18, 1919		818

ORDERS OF THE REGIONAL DIRECTORS

Railway Storekeepers' Association.—The Eastern regional director quotes a letter received from H. B. Spencer, chairman, Central Advisory Purchasing Committee, as follows:

"A meeting of the Railway Storekeepers' Association will be held at the Hotel Sherman, Chicago, Ill., on January 27, 28 and 29, 1919. The status of the association has been approved by the director general, and this is the first meeting which has been held since the railroads were taken under federal control. In view of the important economies which it is confidently expected to effect through the re-organization of the stores department which has been undertaken, and the desirability of having all of those who are charged with the duty of procuring, handling and distributing the material obtain the benefit of personal discussion of the many questions involved, we would appreciate it if you will request your federal managers to arrange to have as many of their purchasing and stores department officers as possible in attendance at this meeting. It is believed that this will greatly assist in the introduction of uniform practices, which it is the desire to establish as speedily as possible."

The Master Boilermakers' Association.—The Eastern regional director states that the Master Boilermakers' Association will hold its convention at the Hotel Sherman, Chicago, Illinois, May 26, 27, 28 and 29, 1919. As this organization has been recognized and encouraged by the railroads on account of its educational value, approval has been given for the holding of the convention. Please arrange for master boilermakers, boiler shop foremen, general boiler inspectors and others employed in a similar capacity to attend, as far as they can be spared without detriment to the service. Each road should follow its usual practice with respect to allowance of time and expenses and furnishing transportation for men who may properly be permitted to attend this convention.

Location of Air Pumps on Locomotives.—The Eastern regional director and the Southwestern regional director have issued orders stating that when air pumps are applied to locomotives, care should be taken that they are so placed as not to obstruct the vision of men on the locomotives; as locomotives receive Class 1, 2 or 3 repairs the pumps should be properly located.

Passes for General Chairmen of Committees of Employees' Organizations.—The Eastern regional director states that it has been decided that it will be the policy of the Railroad Administration to issue annual railroad transportation to the general chairmen of committees of employees' organizations, where the application is properly made and it can be shown that such chairman actually represents the class of employees he claims to represent. This will include also the granting of the necessary leave of absence in the usual manner during the incumbency of such chairman to enable him to carry on the business of his Association. It will be proper to honor requests of this character where annual transportation over the home road only is desired. Requests for off-line transportation should be forwarded to the Director of Operation.

Time Allowed for Lunch to Shopmen on Eight Hour Shifts.—The Eastern regional director states that pending further action by the United States Railroad Administration, the following will govern except when more favorable conditions are provided for by agreements in force: Men employed in shops or roundhouses where three shifts are worked and who work one of the three shifts, will be allowed a lunch period of not to exceed 20 minutes, with pay. Those employed in shops or roundhouses or other places where less than three shifts are worked are to have a meal period of not to exceed one hour, without pay.

Elimination of Sunday and Holiday Work.—The Eastern regional director reproduces a letter from the Director of Operations which is self-explanatory:

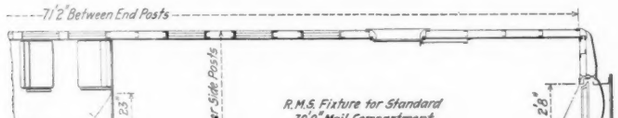
"If you have not already done so, won't you please immediately arrange for a thorough investigation and study to be made on the roads in your region with respect to the elimination of Sunday and holiday work, in order to carry out the desire of the director general as expressed in Supplement No. 13 to General Order No. 27.

"In order that the director general may know what progress is being made, and that his wishes in the matter are being fully met, I believe it advisable that you have your federal managers make reports from time to time indicating to what extent they have found it possible to either wholly eliminate or reduce to the minimum Sunday or holiday work."

Car Inspectors Needed.—The Eastern regional director states that C. B. Young, manager, Inspection and Test Section, 610 Southern Railroad building, Washington, D. C., is in need of car inspectors at plants building cars for the United States Railroad Administration and asks that railroads forward to him the names of men who are at present in their employ who would make good inspectors on car construction, and who could be spared temporarily to take up this work.

STANDARD PASSENGER CAR EQUIPMENT

THE Committee on Standards for Locomotives and Cars of the Railroad Administration has approved the general arrangements for the passenger; passenger and baggage; passenger, baggage and mail, and passenger and mail cars, the floor plans of which are shown in the illustrations. No other drawings, nor the specifications have been drawn for this equipment because of the uncertainty as to whether any of these cars will be built. All the cars are 70 ft. in length and are of the same general design. The



Half Floor Plan of U. S. R. A. Passenger and Mail Car

illustrations show the complete floor plan of the passenger car and half plans of the other cars, as the passenger end of all cars is the same. The designs for these cars will follow in a very general way that of the 70-ft. baggage car, a description of which was published in the *Railway Mechanical Engineer* for October, 1918, on page 561.

The following is a list of the specialties recommended by the committee for the standard passenger carrying cars:

Inside finish: Water and fireproof, ¼ in. mahogany window sills. Three star Agasote below wooden window sill and steel above.

Ceiling: Upper deck water and fireproof—three star Agasote ¼ in. thick. Lower deck water and fireproof—Agasote 3/16 in. thick. Deck to be painted with slush paint. Ceiling to be painted light color enamel of approved shade.

Ceiling decoration: Single plain sap green color line on lower and upper deck. Line only varnished over to hold decoration.

Window sash: Brass sash complete with fixtures as shown on Baltimore & Ohio blueprint No. 10,745. All windows to be double sashed except toilet room windows. Sash to raise 18 in.

Deck panels: All swinging deck panels to be equipped with T. U. Company's Eclipse ratchet. No deck sash to be used, swinging panels only at ventilators.

Window glass: American polished plate 3/16 in. thick, except in saloons and lavatories, which are to be equipped with pressed prism design 0-1, with smooth surface outside.

Door glass: American polished plate ¼ in. thick.

Window shades: Railway standard mercerized on inside, pantasote on outside. Width of curtain goods in windows not more than ¼ in. less than distance between window casing. Color of shade to be selected.

Shade fixtures: Rex, all-metal shade roller. Curtain Supply Company, ring type No. 88.

Shade rolls: Rex, all-metal shade roll.

Seats: Hale & Kilburn, walk-over type, high back, with head rest, steel ends, wooden arm rests, No. 197, or its equivalent.

Seat covers: Seat covering to be selected later.

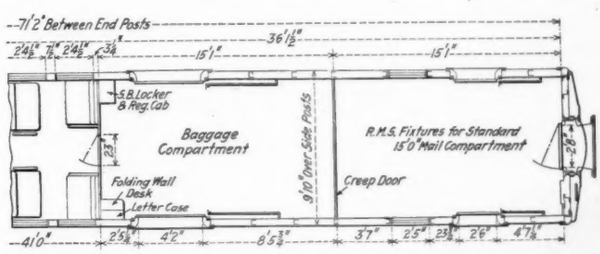
Ventilation: Clere story deck, eight per car. Utilities ventilator 100 per cent, Peerless 90 per cent, Garland-Honeycomb 75 per cent.

Water coolers: White metal, North Pole sanitary drinking fountains with filter attachment, arranged suitably to design of car.

Wash stands: White metal. Plumbing under wash stands to be open with nickel fittings. Wash stands fitted with Adams & Westlake throw-over lever type of faucets and drain fixtures of Pullman standard.

Water supply: Pullman standard air pressure water system. Galvanized steel piping. Cold water only. Metal tank box insulated.

Heating system: Chicago Car Heating Company's vapor system to be guaranteed by manufacturers to register an inside temperature of 70 deg. when the outside temperature is 20 deg. below zero. Holes through center sills for train line sufficiently large to prevent chafing of pipe due to expansion or contraction. Piping so applied as to give ample clearance



Half-Floor Arrangement of U. S. R. A. Passenger, Baggage and Mail Car

between all body and truck parts when cars are rounding 170 ft. radius curve. Same to include extra heavy pipe for train line.

Steam hose and couplings: Steam hose to be 1⅝ in. by 24 in. Couplings to be of the S-4 type.

Steam pipe: Train pipe 2 in. wrought iron. Pipe and fittings extra heavy. Piping inside of car 1½ in. standard pipe.

Foot rests or guards: Pullman type, perforated steel.

Wrecking tools and cases: Steel box fitted with No. 6 sledge, axe, saw, fire bucket, hack saw, six hack saw blades, cold chisel and steel bar, located to comply with state laws.

Hardware: To be of the Pullman type.

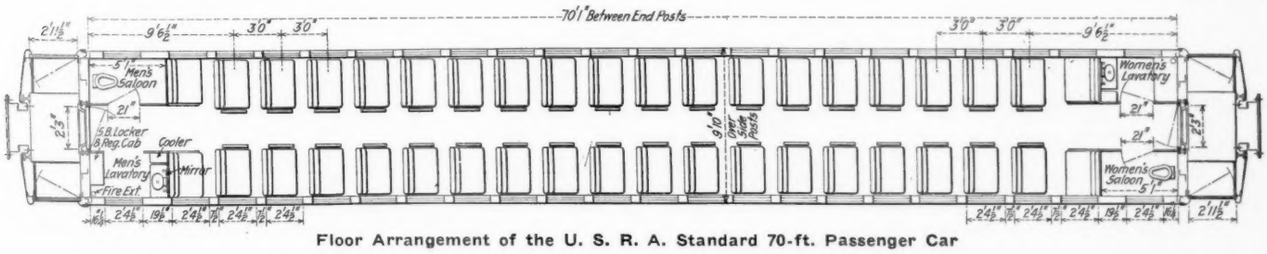
Floor covering: Floor covering to be of plastic material, thickness to meet linoleum ⅝ in. to the top of chanarch, and then an aisle strip of green or red linoleum laid so that the top will be on the level with the inlay and of suitable color to harmonize with the interior finish of the car, chanarch to be 22 B.W.G. gage galvanized. Brass strips to be placed on either side of the linoleum as shown on Baltimore & Ohio blueprint No. 31,189.

Equipment: One deck sash opener. One step box (Dunbar).

Basket racks: Three-section continuous type.

Coat and hat hooks: In saloons and lavatories.

Check holder: Fitch.



Floor Arrangement of the U. S. R. A. Standard 70-ft. Passenger Car

Platform and end of car: Cast steel integral with body bolster as manufactured by Commonwealth Steel Company, or built-up type of approved design.

Gates: Each car to be equipped with safety gates, Pullman type, and permanently attached at each end of car.

Steps: Steps to be of steel with metal safety treads of abrasive material and have no nosing.

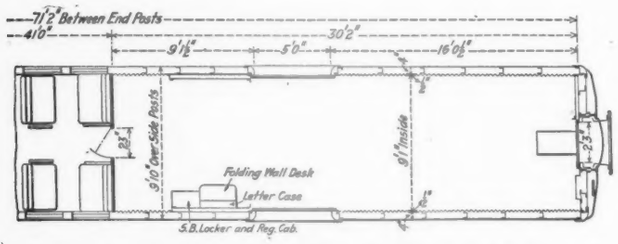
Draft gear: Miner friction class 5-A-P.

Buffer device: Miner friction, Class B-10, or equivalent.

Diaphragm upper buffer: Fowler upper buffer spring.

Vestibule: Wide type Pullman standard, with Imperial wide face plate.

End doors: Mahogany with finger guards.



Half-Floor Arrangement of U. S. R. A. Passenger and Baggage Car

Diaphragms: To be of steel. First choice Dunbar, Style C. Second choice, Pullman. Third choice, Rex.

Vestibule curtains: Pullman, first choice; Acme Automatic, second choice.

Vestibule shield: Pullman or Acme revolving type.

Vestibule curtain, hook and handle: Rex, first choice; Robertson Safety, second choice.

Vestibule trimming: Enameled body color.

Vestibule grab handle: All handholds, grabs, to be smooth wrought iron, ⅞ in.

Trap doors and lifting device: First choice to be T. U. Company's National high station platform type, arranged to open up after and outside of vestibule doors. Second choice, Edwards, and third choice, Pullman.

Air brakes: The Universal, common standard, high-speed automatic brake equipment, schedule UC-1-18, shall be used without electric features and with type K-1 automatic slack adjuster placed on brake cylinder. J. M. expander ring. Ten pound spring type retaining valve and one conductor valve.

The air brake shall develop a nominal brake power of 90 per cent of the complete light weight of the car with 60 lb. cylinder pressure, and be capable of 150 per cent braking power in emergency.

All parts of truck and foundation brake gear to withstand stresses in accordance with M.C.B. standards; 1¼ in. extra heavy brake pipe to be used. All pipe fittings except those regularly included in the air brake schedule shall be "Extra quality individually tested pipe fittings for railroad air brake service." All air pipe to be blown out before pipe is assembled.

Hand brakes: Miner or Western Railway Equipment, or Lindstrom improved.

Braking and signal cord: Signal cord, ¼ in. steel cord, braided green. Conductor's cord, ¼ in. steel cord, braided red, both applied along center of car upper deck supported.

Painting: U. S. Standard.

Roof: Steel. To be of material which has been thoroughly sand blasted, painted and sanded on the outside.

Trucks: Cast steel.

Truck wheel base: 11 ft.

Center plates and center pins: Cast steel separable, arranged for application to cone bolster locking center pin.

Side bearings: Frictionless rolled side bearings for six-wheel passenger trucks. Miner first choice, Perry second choice, Woods third choice.

Equalizers: Wrought iron.

Wheels: 36 in. rolled or forged steel.

Pedestals: Cast steel.

Journal boxes: National Malleable Castings Company's pedestal type complete with lids for axles with 5 in. by 9 in. journals.

Journal bearing keys: To be drop forged M.C.B. dimensions suitable for axles with 5 in. by 9 in. journals.

Brake shoe: Diamond *S*.

Floor insulation: To be 1 in. quilted hair felt with paper on both sides.

Insulation, super-structure: Body insulation to be ¾ in. quilted hair felt with paper on both sides applied to inner surface of the side walls and end sheets.

Saloon hoppers: Dayton Company's Eckert No. 8 with porcelain hopper chute as manufactured by Dayton Manufacturing Company, or Pullman Standard (Duner). Hopper in women's lavatory to have double lid and men's lavatory to have single seat with horseshoe opening. Toilet paper holder, Pullman type, to be applied in each saloon.

Designating signs: Pullman style, to show location of each toilet, one illuminated sign to read "Men" in end of car where men's toilet is located. Sign to be placed inside of car on bulkhead. Same method to be used at ladies' end and sign to read "Women."

THE STANDARD REFRIGERATOR CAR*

The Designs Have Been Based on Results of Investigation Made by the Department of Agriculture

BY M. E. PENNINGTON

Food Research Laboratory, Bureau of Chemistry, U. S. Department of Agriculture

A SHORT time ago the Railroad Administration issued Mechanical Department Circular No. 7,** the opening paragraph of which reads as follows: "In order to insure the greatest possible degree of efficiency in refrigeration and conservation of foodstuffs, refrigerator cars having trucks of 60,000 lb. capacity or over, will, when receiving general repairs or being rebuilt, be made to conform to the following United States standard refrigerator car requirements." Then follow specific details and references to blueprints for the construction of the car in general, its insulation, ice boxes, and the many details of a refrigerator car.

Considering the fact that we have in this country more than 100,000 refrigerator cars, and that ultimately all will probably conform to the essentials just laid down by the Railroad Administration, it may not be amiss to review the circumstances which have led to the issuance of this circular.

In the latter part of the nineties and early hundreds the difficulties in the distribution of our perishables attracted an increasing amount of attention because the length of the hauls increased as more distant markets demanded supplies, and the losses from decay in transit kept pace with the distance traveled. Some of the shippers applied to the United States Department of Agriculture for assistance, among them the Georgia peach growers. In 1903 G. Harold Powell and his associates undertook to investigate the matter. They studied the effect on ripening of cooling the fruit quickly after picking and before loading in the car, as well as the development of decay in transit. Precooling, however, was not a reliable remedy because the insulation of the refrigerator cars of the south was, and is, insufficient to retain the chill imparted to the fruit and the air circulation in the cars was, and is, inadequate to transfer the refrigeration from the ice bunkers to the center and top of the load.

From Georgia peaches the investigators were called to California oranges. The industry was severely handicapped because of decay in transit. Again the inadequacies of the refrigerator cars were apparent. The investigations of the temperature in cars in transcontinental trips brought out the differences in various parts of the car and their relation to excessive decay in the middle and upper part of the load.

In 1908 the Food Research Laboratory, which had been studying the effect of long cold storage on poultry, extended the work to the handling of fresh goods in the packing houses and in transit. We soon found that standardized methods at the packing house did not give standardized results at the market; in other words, the refrigerator cars were a variable factor. It was not and it is not uncommon to find chickens on the floor at the bunker hard frozen, those quarterway of the car in a good chilled condition and between

*Abstract of a paper read before a joint meeting of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers.

**See *Railway Mechanical Engineer*, December, page 663.

the doors green struck, although the condition of the packages was practically uniform when they were loaded.

Then began the study of the construction of these cars. In 1913 the results were published as Bulletin No. 17 of the United States Department of Agriculture. The conclusions presented in that bulletin outline fairly well the lines of work since followed by the investigators and which have led to the information on which the construction of the standard refrigerator car is based. The concluding paragraph of the bulletin says, "It is eminently necessary that such questions as the most efficient and economic size of the refrigerator car, the exact amount of insulation required to insure the maintenance of low temperatures, or, conversely, to protect the contents of the car against frost, the equalization of temperatures in all parts of the car, and many others, be pressed for more exact and far reaching answers." The bulletin points out the importance of roof and floor construction in relation to insulation efficiency, especially the waterproofing of the floor, and also the efficiency of the wire basket bunker which permits of abundant air access to the refrigerant.

By the early spring of 1916 we had ready quite a number of experimental cars built by four roads in as many shops. The details of construction varied widely. This we considered advisable because we first had to establish the fundamentals of construction, such as the type of bunker and the action of floor racks, regardless of the car itself.

AIR CIRCULATION

It did not take long to decide that the basket bunker, insulated bulkhead and a rack four inches off the floor, with lengthwise stringers and cross slats about three inches wide and about two inches apart, are essential for the distribution of the refrigerated air. The wire basket hanging free in the end of the car permits the warm air entering at the top to flow without obstruction over the entire surface of the ice, and as it cools, to fall to the floor. At the floor it is not pocketed, but finds a ready exit under the rack, and so along the car floor and up through the load, gathering heat as it goes and carrying it to the upper bulkhead opening where again the ice has a chance to absorb it.

If we place thermometers in the air of the car to determine its temperature at the lower bunker opening, again at the middle between the doors, then at the ceiling, midway of the car, then at the ceiling quarter way, and finally about 10 in. in front of the upper bunker opening, we find a steady rise in temperature, the upper bunker opening thermometer being the highest. Generally we find from two to four degrees difference between the air in the upper middle part of the car and that at the upper bunker opening. If the thermometers are similarly placed in a car equipped with a box bunker with open bulkhead and without the floor rack, the graduations of temperature in the upper part of the car are just reversed. Here the temperature at the upper bunker opening is ordinarily from two to four degrees lower than at the middle of the car. This observation has been made again and again and is further confirmed by the performance of a box bunker combined with solid bulkhead and a floor rack, with which there is good cooling in the top of the load at the bunkers, but unsatisfactory results in the upper middle parts of the load.

Even more striking are the results obtained when salt is added to the ice in the basket bunker combined with the insulated bulkhead and floor rack, or the standard type bunker, as it is now termed. So rapid is the removal of the very cold air from the bottom of the bunker that fruit and eggs may be rapidly cooled throughout the car without frosting the packages at the bulkhead. Of course, the bulkhead insulated with one or two inches of a standard insulator is an essential if the packages against it are to be protected from the frigid air close to the ice and salt, but that this protection is not due entirely to the bulkhead is proved by the pocketing of the cold at the bottom of the bunker when the box bunker with an insulated bulkhead is salted. Then the packages at the bottom of the load, next to the bunker, are frosted. In other words, there is no force to the air movement and it cannot be distributed with sufficient rapidity to prevent the intensive chilling of itself. With the standard bunker and floor rack and a lading such as cantaloupes or oranges, as much as 9 per cent of salt may be safely used in the initial icing, and the same percentage or a little less may be used on the two successive days, by which time the load is cooled throughout. It is unnecessary to point out the great advantages accruing to the transportation of such perishables as berries, peaches and cherries by this ability to cool them rapidly while rolling. It is also of benefit to eggs, which, because of the character of the commercial package and the tight load, are exceedingly slow to cool in the ordinary car, the top and middle of the load being but little affected.

The question of insulation has been more complex. We have not only a compound wall, but one which is continually in vibration and which is moving constantly. To this constant movement of the insulator must be added the difficulties of making it continuous because of the framing of the car and the use of tie rods and bolts which offer heat runways.

INSULATION

The thermometers which were fastened tightly against the lining of the car very promptly and consistently indicated that roofs and floors must be better protected than the walls, and in the case of the floor and the lower part of the walls it is imperative to waterproof. Comparisons of cars having varying amounts of insulation, loaded with representative commodities, showed that for the safety of the load, as well as economy in loading and in refrigerant, it is necessary to have the equivalent of two inches of pure cork board in the side walls and ends, at least two and one-half inches in the roof and at least two inches in the floor, the insulation in the floor to be continuous from side to side and end to end. In other words, the insulation on the floor must not be broken by sills and it must be at least two inches of pure cork board.

It has not been possible, heretofore, to waterproof the floor. Consequently there has been wet insulation and a serious loss of efficiency. Therefore the findings of the department emphasize the need of cork board in the floor.

THE GOVERNMENT STANDARD REFRIGERATOR CAR

Such essentials of a refrigerator car as an adequate amount of insulation and air circulation had been agreed upon by the investigators prior to government control of the railroads, and certain lines had incorporated some or all of the findings into their new and rebuilt cars. In the standard refrigerator car* developed by the Railroad Administration, so far as possible, the trucks, draft gear, framing and other general construction features are standardized with the United States standard double wall box car. The essentials upon which rest efficiency in protecting perishables against heat and cold have followed very closely the findings of the investigators of the Department of Agriculture. The plans include unbroken insulation on both floor and roof. On the walls the insulation is continuous from door post to door post. It was not possible to devise a scheme by which the insulation could be run over the belt rails, but the exposed surface was reduced. All the insulation is applied in a solid mass, unbroken by air spaces. It is supported by pressure and not by direct nailing. The excess space afforded by the framing is left on the inner side, under the lining, to receive such nails as the shipper cannot be prevented from driving into the walls and which have played havoc with the insulation. Bolt heads and tie rod exits are protected by insulation. The bunker is a woven wire basket holding approximately 10,000

*See *Railway Mechanical Engineer*, December, page 663.

lb. of ice, surrounded by a 2-in. space and separated from the body of the car by a bulkhead carrying at least 1 in. of insulation, and last, but far from least, is a floor rack, 4 inches in the clear, built of 2-in. by 4-in. runners with 1-in. by 3-in. cross slats 1½ in. apart. This rack is hinged to the side walls. Each half may be turned up and the doorway section folds back to facilitate cleaning the car. The length of the car over end sills should be about 41 ft. and the loading space 33 ft.; it must not be more than 33 ft. 3 in.

FUTURE DEVELOPMENTS

On the basis of a standard car the department is now predicating a standard icing service which should save foods and money. It is also working on standardized methods of stowing loads and the standardization of packages. The ability quickly to cool certain commodities in transit by the use of salt with the ice has given a new impetus to orchard, field and packing house handling, while the reasonable assurance of proper care in transit of such products as dressed poultry lends a stability to the industry which is much needed. There has been much discontent on the part of shippers of products requiring intensive refrigeration because they could not obtain such cars as the large meat packers are using. The United States standard refrigerator car will carry meat hung from rails quite as successfully as the cars built especially for meat. In addition it will carry package loads on the floor under the meat better than the meat cars. An important difference in the standard car as compared with the meat car is the reserve of ice in the bunkers which are often amply supplied when the tanks of the meat cars need replenishing. Neither is there visible in practicable results the advantages supposed to accrue from the retention of the brine, provided coarse rock salt is placed *on top of the ice* and so forced to bore its way through the whole mass before finding an exit. We have wasted much salt in the past, as well as ice and foodstuff for lack of knowledge.

For every standard car turned out of the shops there will follow a saving of food, a saving of money and a saving of labor. To that end the Department of Agriculture has worked long and patiently and to that same end the Railroad Administration has now issued Mechanical Department Circular No. 7, and has also indicated its intention of reminding the railroads of the instructions.

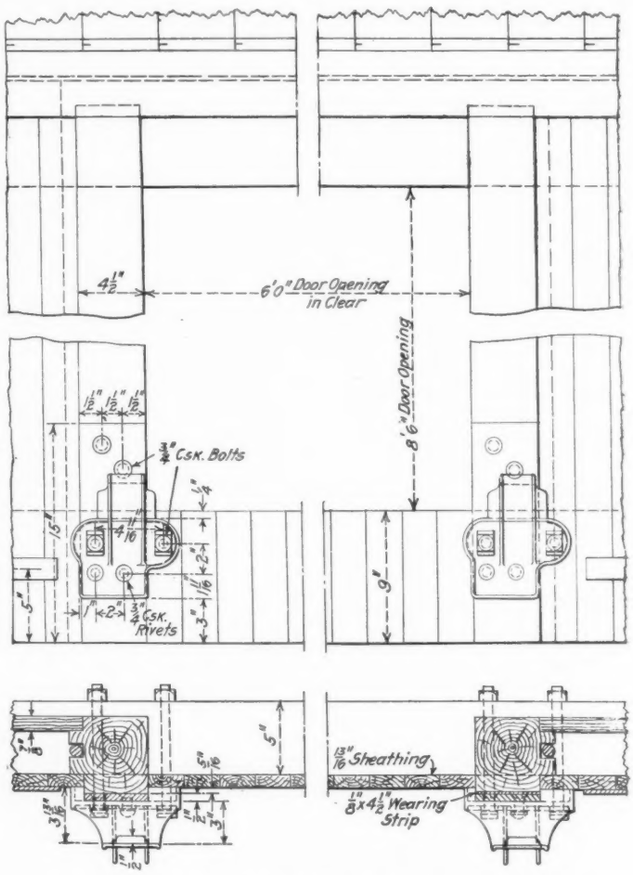
Truly, facts, faith and friendly co-operation have brought about a consummation long and earnestly desired.

MAKING BOX CARS EFFICIENT GRAIN CARRIERS

BY E. K. HOGAN

Investigation shows that a large majority of all the leaks of grain from box cars occur between the car sheathing and the side sills, due to the tendency of the sheathing to spring away from the sills under load. Nails do not effectively and permanently hold sheathing boards firmly and tightly to the sills under the strain to which cars are subjected.

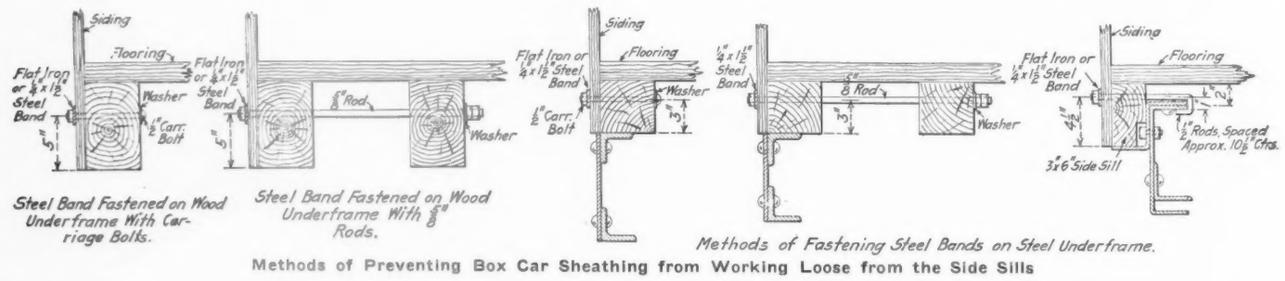
One successful remedy for this condition has been the application of sheathing straps of flat iron, size ¼-in. by 1½ in. to the sides of the box cars. These straps are fastened by bolts through the side sills together with rods that extend through both side and intermediate sills. It has been the observation that no more adequate protection against sheathing leakage than these straps can be applied to a car. In applying straps of this kind it will be found that iron of the dimensions given above is much more desirable than straps of greater width, which would not shed moisture as well and might cause the sheathing to rot under the straps.



Box Car Door Guides with Steel Plate Attachment Bolted to the Door Posts

On some steel underframe cars the sub sill is of such light weight or the frame of such construction as to preclude the application of bolts to hold the sheathing straps. This difficulty has been met by the use of J-bolts, as shown in Fig. 1.

Some grain losses are ascribed to the prevalence of warped, twisted and loose grain strips. It has been our experience that this leakage is primarily due not to faulty grain strips but to the fact that flooring is improperly and insecurely fastened to side sills. Flooring fastened by nails to the side sills will in course of time spring up at the ends, which per-


Siding
Flooring
Flat Iron or ¼ x 1½ Steel Band
Washer
½" Carr. Bolt
5"
Steel Band Fastened on Wood Underframe With Carriage Bolts.
⅝" Rod
Steel Band Fastened on Wood Underframe With ⅝" Rods.
¼ x 1½ Steel Band
10"
⅝" Rod
3" x 6" Side Sill
1" ½ Rods, Spaced Approx. 10½" Ctrs.
Methods of Fastening Steel Bands on Steel Underframe.

Methods of Preventing Box Car Sheathing from Working Loose from the Side Sills

mits grain to run underneath floor and over the inside edge of side sill.

The only remedy that would overcome this condition would be to bolt the flooring to the side sills, and it is the recommendation that straps of flat iron, the same size as those applied to the sheathing, be applied to the flooring along the side sills just inside of the post line. These straps should be fastened by bolts extending down through the sills. This method would be much more secure than placing bolts through the grain strips, which are in short lengths and liable to split. The use of sheathing and floor straps, both bolted through the side sills, together with adequate door protection, would make cars of wooden construction grain tight.

Many experiments have been made by railroads to discover a box car side door that will successfully perform its functions. As a result the up-to-date box car usually has a strong, durable side door. The greater problem really has been to hold it properly to the car. Success in this depends largely on the door post and the door guides. Grain doors are nailed to the door post and when removed the nails are left in the post which weakens it considerably and lays it open to moisture and rot. Because of this all door posts should be equipped with a well fitted nailing strip of at least 1¼-in. stock covering the entire inside face of the post.

Insecure doors and grain leakage is often caused by door posts being burst out because of rotten tenons or other reasons. A remarkably good arrangement to strengthen the door post has been successfully applied by one road to all of its box cars. This is shown in Fig. 2. The door post, besides being tenoned into the side sill, has an outside extension down to the bottom of the sill. A wrought iron plate is fastened to the door guide by means of two rivets. This plate extends up the post, to which it is secured by two bolts. The two bolts through the door guide pass through the side sill, one of them also passing through the extension of the door post. This not only holds door post in place but makes it impossible to pry or hammer down the door guide to gain entrance to the car. It is a more economical and as satisfactory as any of the so-called "burglar proof" door fixtures on the market.

Grain spoiled or damaged by water on account of leaky roofs is so much grain lost. To avoid breaks and leaks a roof must be flexible. It is contended that the most satisfactory roof yet discovered is the steel roof of heavy gage metal. Without taking issue with this assertion I wish to describe a method of applying the much derided light metal roof which has been found to make it wear 50 to 75 per cent longer. A single board wood roof is first laid over the purlines, crosswise of car. This is given a heavy coat of Baco or Sarco preparation and covered with one layer of plastic paper, over which the roof sheets are laid. It has been found that the tar in the paper is an excellent lubricant and preservative of the metal. This preparation, besides its waterproofing qualities, prevents nails that become loosened in the board roof from wearing their way up through the roof sheets.

LUMBER FOR CAR CONSTRUCTION*

Selecting Proper Grades to Secure Strength and Lasting Power, Increasing Service by Preservatives

BY DR. HERMANN VON SCHRENK

A GOOD many years ago I went abroad to study questions of economies in maintenance. The most impressive fact which I came back with was the striking view point that most of the European engineers had of the necessity of a thorough comprehension of the materials that they were working with and their high degree of respect for what they were working with. They furthermore, did not hesitate to change their methods of using material, provided some way was shown to them by which they could bring about not only greater economy but increased fitness and adaptation. We in this country have been prone to stick to precedent. The tendency to continue methods simply because they have been in use a great many years is characteristic of much of our railroad practice. We are rather slow to change, particularly when it comes to the question of using material. It is not astonishing that we have got into such habits, because in the first place we have had such an enormous amount of raw material and it has been easily available. If there is one lesson that the war has taught us it is that we have been slipshod in the use of our material.

One of the chief difficulties in the construction of cars, referring of course entirely to lumber, has been the extremely vague way in which most of the lumber used in a car has been described and the even vaguer appreciation on the part of those who are repairing cars as to what might be expected of various kinds of wood. The lumber men and the officers of most of our roads specified one or two kinds of wood because they had always been used. White oak and white pine were the woods that were most readily at hand in the earliest days and were long recognized as the best. Consequently for years they were specified and used and they are still being specified. This is a remarkable fact; it is not only the case with the railroads but also with the government. I was present at a meeting revising government specifications for lumber and it was found that they called for clear white pine an inch and a quarter in thickness, dressed on both sides—lumber which has not been manufactured for a great many years.

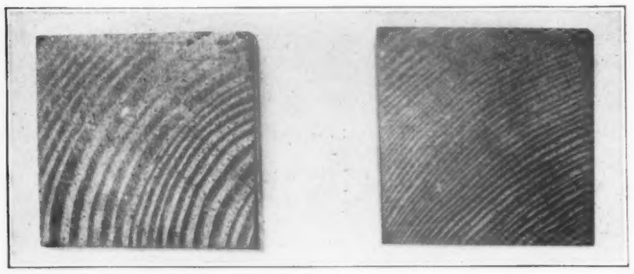
Now what has been done for the average man interested in the construction of cars that might enable him to get better service out of the material? The best way in which he can do that is to specify more closely the kind of lumber that he wants for his construction and to specify it so that he will get a reliable class of material. The specifications under which lumber was bought in the last year on one of our biggest trunk line railroads was "yellow pine, long leaf, grade B or better." It is against that kind of practice that I would caution you.

As a result of a long series of studies made in co-operation with the American Society for Testing Materials and the U. S. Forest Service, a standard specification was adopted by which yellow pine lumber could be visually inspected instead of describing it. I have a chart which was furnished me by the engineers of the United States Forest Service, having four pieces of long leaf yellow pine (Fig. 1). They are all botanically long leaf pine, but you will notice the modulus of rupture varies from 11,110 lb. to 4,660 lb. per sq. in. There is not any way in which you could identify these as long leaf pine; you would have to accept it under

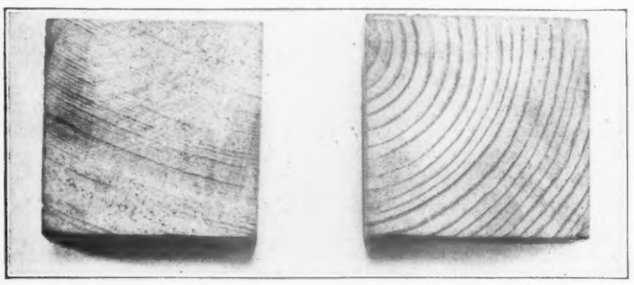
*From an address before the Western Railway Club.

the usual specifications, but notice the difference in the quality which is furnished. From this you will get an idea as to what grade of pine ought to be specified, particularly from the standpoint of strength. If you want a piece of timber in a car where strength is required as in sills, posts or braces, the specifications should call for a dense piece of pine instead of the ordinary long leaf pine, because in specifying that you will get a strong piece, as you will see from the chart. The term "long leaf" does not take care of that.

After the density rule had been developed some members of the M. C. B. Association raised the question, "Are we sure when we specify this grade of dense pine, that we will also get a stick which will last?" A few years ago the poorest as well as the best grades of southern pine were put under a testing machine to determine their strength and were also submitted to decay producing influence, in order to see whether there was any relationship between the strength and the lasting power. It was discovered that the strong pieces were also the ones that had the greatest length of life. The results of these tests are shown on the curve in Fig. 2. This demonstrates clearly that if you obtain a good, dense-grained piece of southern pine, you will also obtain a long-lived piece. In making experiments with car sills for the last few years, I have been impressed with the fact that those in which a high



Modulus of Rupture.....	11,110 lb.	Modulus of Rupture.....	10,750 lb.
Specific Gravity	.639	Specific Gravity	.598
Per Cent Summerwood...	55	Per Cent Summerwood...	52
Rings per inch.....	10	Rings per inch.....	23



Modulus of Rupture.....	4,660 lb.	Modulus of Rupture.....	5,520 lb.
Specific Gravity	.432	Specific Gravity	.440
Per Cent Summerwood....	....	Per Cent Summerwood....	25
Rings per inch.....	32	Rings per inch.....	10

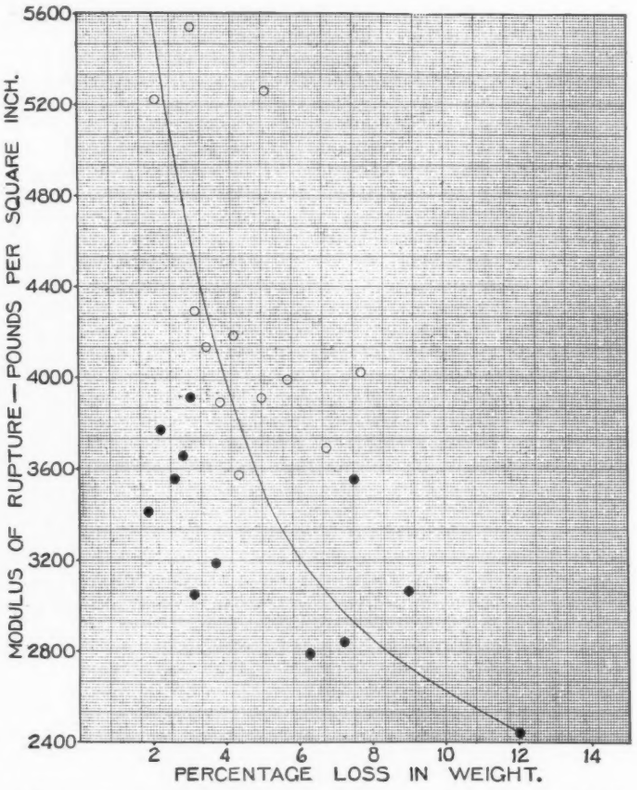
The two upper blocks show typical sections of timber with a large percentage of summerwood. Both have high density or specific gravity and a high modulus of rupture, although the rings per inch vary greatly. The two lower blocks show a small percentage of summerwood. The specific gravity is low in both cases and the modulus of rupture shows the ultimate strength is only about one-half as great as for the dense wood. The tests were conducted on small, clear specimens of green material.

Fig. 1—Samples Illustrating the Properties of Yellow Pine

percentage of failure was found were the pieces that fall in the low part of the curve. The pieces which brought the car to the shop were in very rare instances the pieces that were in the high points of the curve.

A third series of tests was made to determine whether we had to specify long leaf pine at all. The question was raised two years ago in one of the committee meetings of the M. C. B. Association as to whether it was safe to use pine lumber other than the strict long leaf variety brought from Louisiana, Texas, Alabama or Georgia. Without going into details I will state that it makes no difference whatever what kind of pine tree the lumber comes from, whether it is lobolly, short leaf or long leaf: all have equal lasting power or strength, provided they are of the same density and provided they are all heart wood. In other words, exclude young saplings and you will get as long life out of one as out of the other, provided it has the same density. The comparative resistance to decay of heart wood and sapwood is well brought out in the samples as shown in Fig. 3.

A great deal has been said about the possibility of increas-



Two samples were taken from the same piece. One was broken in the testing machine and the other was subjected to decay producing influences for 18 months, after which it was dried and weighed. The percentage loss of weight indicates the amount of decay that had taken place. The strongest pieces also showed the highest resistance to decay.

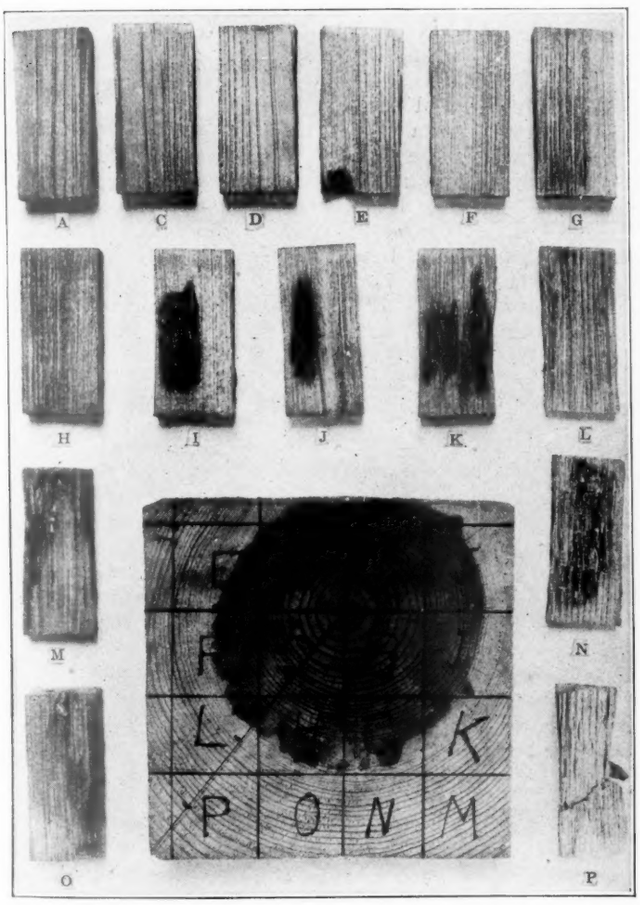
Fig. 2—Curve Showing the Relation Between Strength and Resistance to Decay of Southern Pine

ing the service of lumber after we buy it by some kind of preservative treatment. It is rather surprising that the car men are so far behind the rest of the engineers in availing themselves of that opportunity. There are only two roads, the Burlington and the Santa Fe, so far as I know, that make a practice of creosoting sills and flooring, particularly of stock cars. I recently examined some cars that the Burlington built, over five years old, none of which have come back for repairs. They have creosoted sills and creosoted flooring, and in all of the cars the creosoted parts are in just as perfect condition as the day they were first put out. Now, if the Burlington can get such service out of creosoted lumber, is it not a shame for us to get three or four years' life out of material, when we might increase the length of life we ordinarily get five or six times?

Do not understand me as advocating anything less than a system of impregnation which will force the preservative into the timber. At the present time that is not very practical because our supply of creosote is short, but when normal conditions are restored I do not see why we cannot have a widespread treatment of car parts which are not subject to mechanical stresses, but in which lasting power, namely the

protection against decay, is a vital factor. The ordinary scheme which I have seen applied here and there, the spraying of a preservative on timber, I personally have little use for, because a perfect impregnation is not obtained. The expectation of a prolonged life cannot be secured, so the spraying of the preservative onto the car is more or less a useless proceeding and a false protection. Putting it over joints and tendons when pieces are put together may be of some slight protection, provided the lumber is absolutely bone dry, but the practice of putting preservatives on promiscuously should be discouraged rather than encouraged.

One other factor in car construction that will assume increased importance in the near future is a more careful selection of kinds of woods for special types and purposes. I have referred to the fact that we have used only one or two kinds of wood in the past; we are still doing that to a large extent at the present time. There are a good many woods



This illustrates the rapid deterioration of the sapwood and the resistance to decay of the heartwood. The letters on the small blocks correspond with those on the larger block.

Fig. 3—Blocks of Shortleaf Pine After Being Subjected to a Wood-Decaying Fungus for One Year

available which ought to be used more widely than they are at the present time. Beech is one of them that is rapidly coming into use. I know of one road that has used beech very freely mixed with various kinds of red oak. If used in places where the material is not subject to decay, for instance, in the interior of finished cars, for posts and braces, particularly in the upper section of the car, it ought to give just as good service as oak. With the great trouble we have had in getting car lumber the increased supply of beech available for construction, particularly for box cars, is going to make a very welcome addition to our depleted stocks.

There is another wood which, when our tropical commerce becomes re-established, will play a large part in the construction of refrigerator cars. That is the balsa wood, weighing about 7 lb. per cu. ft., or about half the weight of cork.

The field for the saving of lumber in various lengths and sizes is too big to more than refer to. If there is one place in railroad construction where closer adaptation of different sizes and lengths and particularly grades of different lumber can be obtained than in the car repair shop I do not know where it is. I recently tried to compile a list of the requisitions as issued by the car department on one of the eastern lines for different uses in repairs of freight cars and tried to correlate them by substituting grades which I knew would serve the purpose of the railroad equally well as some of the other woods. I hate to tell you the difference in cost.

With the increased refinement in the grading and manufacturing of various kinds of lumber, I believe it to be the duty of every man interested in repairs of cars to study with the greatest care the revised grading rules which have been established by the various lumber manufacturing associations, for hardwood as well as pine and fir. These associations issue also engineering manuals, and no car man ought to be without them. If that were done such specifications for lumber for cars as I have found in use on some railroads would become practically impossible. One of the biggest railroads running out of Chicago in its specifications simply gave two words to the discussion of the timber, said a few words about the dimensions and practically told the man who was going to furnish the lumber, who was the purchasing agent, to use his wits. They wanted some wood; that is about all the specifications said. If you look over your own specifications and ask yourself, to what extent that example has been followed, you will know what ought to be done.

DISCUSSION

A. LAMAR (Penn. Lines): I would like to ask whether balsa wood can be secured for car construction?

DR. VON SCHRENK: Practically all that is available is used for life preservers. The wood, however, will probably be very much more plentiful when our shipping facilities are rearranged. It is found in Brazil, Costa Rica and the West Indies. It is heavily impregnated with paraffine because it is very short lived otherwise. It is a remarkably strong wood considering its light weight and it is an almost perfect insulator. As soon as it is available in larger quantities it ought to be of great value as lining for refrigerator cars.

G. S. GOODWIN (C. R. I. & P.): Dr. von Schrenk has mentioned preserving lumber for car construction. Would he stop with the sills or would he apply preservatives to the posts, braces, siding and roofing?

DR. VON SCHRENK: That would have to be determined by the type of car and by the grade of lumber being used. It might be advisable to use it in the first place in stock cars or in any cars where the wood is subject to a maximum degree of deterioration because of decay. The requirements are different for the lumber used in different parts of the car, because some pieces in a car are destroyed mechanically by abrasion, by shocks due to the impact of one car against the other or by other factors which cause the material to break mechanically. The other cause of depreciation is rot or decay. Against mechanical destruction no amount of preservation will avail; against decay, preservation will bring about excellent results. Obviously it is a very foolish proceeding to expend money on preservation of those parts of a car that would be subject to a very short normal life due to shock or breakage. I found the places in cars where it would pay to use preservative to be the sills in all types of cars and all flooring, and possibly also the posts in cars which are subject to continuous moisture, particularly stock cars. I doubt whether it would pay, unless a low grade of

sap lumber were used, to treat all parts indiscriminately. In some types of roof construction it would undoubtedly pay to treat the roof boards also, particularly where there is more or less leakage. That may mean that you want to use two different types of preservative. In the case of sills and flooring in stock cars, the only thing that you could afford to use would be creosote. In the case of posts or roof boards which would not be subject to the wetting and drying you could well afford to use the cheaper zinc chloride. It would have the additional advantage that the material would not be disfigured, and it would probably give a sufficiently increased length of life to pay for the original investment.

H. S. SACKETT (C., M. & St. P.): The railroads should be more insistent and more careful in demanding a better class of material for car sills, car framing and other parts where strength is important. One of the mistakes that railroads generally make in the use of wood is that they do not season it properly before they use it. We are not giving wood as good a chance as we do other materials. I know that the railroad officers do not like to see a lot of lumber piled up around the yards, but if they could be impressed with the added service obtained from properly seasoned wood, they would not object to larger lumber piles.

In many cases the railroads are using a better grade of wood than is necessary and that is one field in which we can develop great economies. It has been the custom of the railroads generally to use clear material for car siding. In Douglas fir we use No. 2 clear and better and in yellow pine B and better, not only for the construction of new cars, but also for the repair of old cars. By far the larger part of the material is used for the repairing of old cars which may have a life of five or possibly ten or twelve years. The Chicago, Milwaukee & St. Paul is considering the use of "sound knotted" material for car siding. Clear material costs about $36 a thousand and sound knotted material would cost about $24. I do not see why a good sound knot should be objectionable in car siding. I do not mean encased, loose, unsound or black knots.

DR. VON SCHRENK: I cannot see any objection to using that class of material. I think that it is simply another case of precedent. All you care for in the siding of a double sheathed car is to keep it weather tight, and it does not make any difference particularly what the outside looks like.

MR. SACKETT: In the use of southern long leaf yellow pine the question of how much sap should be allowed has always come up, whether used for a carsill, car framing, stringer or other purpose. In the Douglas fir, the question of sap has not been so prominent, probably because the sap in the Douglas fir is not of the same character as the sap in the yellow pine—it does not rot so quickly. I should like to ask Dr. von Schrenk's opinion with regard to that. In the case of carsills for example, assuming in the yellow pine it was required that 85 per cent of the material should be heart wood what would be the equivalent in the Douglas fir? In other words, what is the comparative life of the sap in the two woods?

DR. VON SCHRENK: If in the pine 85 per cent girth measurement was required to be heart wood, I should be inclined to require the same in the fir. I am judging from recent experience with bridges that had pine and fir timbers. In the same length of time they were both practically in the same state of decay. It should be rather easier to conform to the requirements in the fir, owing to the smaller percentage of small timbers.

ALL-STEEL COACHES FOR THE EGYPTIAN STATE RAILWAYS

BY FREDERICK C. COLEMAN

Thirty all-steel third-class passenger coaches have been put into experimental use on the Egyptian State Railways, and these are now being largely used in connection with the transportation of military personnel. The leading features of the design are clearly shown in the photographs. The cars are 65 ft. 6 in. long over the platforms and have a maximum width over the belt rail moulding of 9 ft. 7⅞ in. The cars have a light weight of 73,360 lbs., and are designed to carry 107 persons seated. The trucks have Fox pressed steel frames, with a wheel base of 8 ft. and 4¾ in. by 9 in. journals.

The panelling and framing is of steel throughout, finished on the inside with asbestos board. The coaches may be

Egyptian State Railway Steel Passenger Coach

freely washed out with a hose without any risk of water lodging so as to cause corrosion. The floors are of Decolite cement, provided with wash-out plugs, and experience in the hot climate of Egypt has proved them to be quite as cool in hot weather as the ordinary wooden type of coaches. The all-steel coaches have the added advantage that they can be cooled down more readily after sun-down than the wooden coaches as a result of the system of air circulation between the outer and inner walls.

The underframe and body are incorporated into one structure. The body side pillars are connected at the bottom through the side sills to the boxed ends of the underframe crossbars, except at the bolsters, and at the top they are

connected direct to the carlines, a method of construction which makes for several strong girdles completely around the body and frame. These are further stiffened by diagonal braces between the backs of the seats fixed to the pillars at their upper ends, and to the underframe crossbar flanges at their lower ends. A test load distributed along the floor caused practically no deflection. Free air circulation is provided throughout in the body between the outer and inner linings. The asbestos lining is carried inside the body sides and the lower roof with a free air space of 8¾ in. at the roof centre. As previously mentioned, the design is so arranged that there is no place for lodgment of moisture in the panels and frame, and as a further means of preventing corrosion the bodies are arranged in such sections that they can be thoroughly stoved after they are prepared for erection. These coaches are built for the 4 ft. 8½ in. gage, and the draw-gear, buffing gear, brakework,

Interior of a Partially Finished Coach Showing the Steel Frame Work

journal boxes, wheels and axles, trunks and other details, such as windows, louvres, seats, lavatory and other fittings, have been arranged to accord with the standard practice of the Egyptian State Railways. The existing timber coaches have tare weights per passenger of from 836 to 992 lb. As compared with these the steel coaches have each an average of 685 lb. per passenger. This advantage in weight is due in a measure to the reduced thickness of sides which permit an extra passenger on the transverse seats. Without thus utilizing this extra seating space or by giving each passenger additional room the tare weight would then show about 810 lb. per passenger. The makers claim that this result will certainly be improved upon when orders for steel coaches are given in the same quantities as is usual in Great Britain for timber coaches, and experienced builders are given a free hand in design and manufacture. Such large orders will permit of the scantlings of the required sizes being more readily obtained, and the net result will be that the railways will undoubtedly benefit, and obtain even lighter coaches than has been possible in existing circumstances. Briefly summarized, the all-steel coaches have the following advantages when compared with the timber coaches as used on British and Colonial railways. They are lighter in structure, with increased capacity; they are stronger and better able to resist wear and tear; they have proved to be quieter in running; they are more economical in first cost and maintenance; there is no danger from fire, and the strong construction of the ends, which have strong vertical girders with very rugged corner pillar pressings, will prevent telescoping. These all-steel coaches were built by the Leeds Forge Company, Limited, of Leeds, England, and the designs were prepared and developed by the builders in collaboration with R. G. Peckitt, the chief mechanical engineer of the Egyptian State Railways, Cairo.

ANNUAL REPORT OF I. C. C. BUREAU OF SAFETY

The following is an abstract of the annual report of W. P. Borland, chief, Bureau of Safety of the Interstate Commerce Commission, for the fiscal year ending June 30, 1918:

The following analysis affords opportunity for ready comparison of the results of inspections of safety appliances on railroad equipment with previous years:

	1914	1915	1916	1917	1918
Freight cars inspected	790,822	1,000,210	908,566	1,100,104	1,059,913
Per cent defective..	5.79	4.77	3.72	3.64	3.92
Passenger cars inspected	26,746	33,427	27,220	29,456	25,732
Per cent defective...	1.04	2.85	1.82	.85	.56
Locomotives inspected	32,761	38,784	31,721	37,199	33,806
Per cent defective...	4.98	4.06	3.66	2.69	2.18
Number of defects per 1,000 inspected.	67.48	57.23	45.56	41.16	44.01

It is to be noted that the present report indicates the maintenance of the low percentage of defects found in equipment inspected which has obtained for the past three years, which is all the more remarkable considering the increased traffic, congested conditions existing during the months of December, January, and February, abnormal weather conditions of last winter, scarcity of labor and materials, etc.

Table I presents a classified summary of the defects reported by the commission's safety-appliance inspectors. Analysis shows that the condition of air-brake equipment, to which attention was directed in the last annual report of this bureau, has not improved. Out of a total of 49,270 defects reported, 24,707, or practically 50 per cent of the whole number, are defects to the visible parts of air brakes. The number of air-brake defects reported per 1,000 cars inspected was 22.07, as against 19.01 for the previous year. The number of freight cars inspected in 1918 was 1,059,913, as against 1,100,104 in 1917, showing a decrease of 40,191 in the number of cars inspected; but the number of air-brake defects reported increased from 22,181 in 1917 to 24,707 in 1918, an increase of 2,526.

This is a condition that demands serious attention on the part of those who are responsible for the maintenance of this equipment, as both safety and economy in train operation require the maintenance of air brakes to the point of their maximum efficiency. On level roads, where braking conditions are less severe than on roads having steep mountain grades, there is a tendency to neglect air-brake maintenance, thus imposing an excessive burden on the inspection and repair forces of the latter roads in order to provide for the safe movement of cars received in interchange. No logical reason for this tendency ever did exist, as a proper compliance with the provisions of the safety-appliance laws requires that brakes be maintained to the same degree of efficiency on level roads as on roads having steep mountain grades. Now that the roads are being operated by the federal government as a unified system the disappearance of this tendency may be looked for.

Table II represents the condition of the air brakes on trains as they left the terminals after terminal or standing tests had been made, and illustrates the importance of these tests. What is often believed to be a 100 per cent air-braked train is in fact much less. The standing test is the only reliable and efficient method of ascertaining the condition of the individual brake, on which, if found to be

inefficient, adjustments can be made at once which will insure an adequate brake. A standing test should be made of each and every train before it leaves its terminal, and no car should be permitted to go forward which has an inoperative or inefficient brake.

The Eighth Circuit Court of Appeals in a recent case held that every hauling or handling of a defective car for any other purpose than repair is forbidden by the terms of the proviso of section 4 of the act of 1910. That is, that a defective car cannot be handled for the purpose of delivering its load to the consignee even when unloading is necessary for repair, unless it be affirmatively shown that such delivery involves no more movement or handling of the car than unloading it or transferring its load.

TABLE I.—Classified Summary of the Number of Defects Found per 1,000 Cars and Locomotives Inspected During the Fiscal Year Ending June 30, 1918

Couplers and parts	4.21
Uncoupling mechanism	4.50
Visible parts of air brakes	22.07
Handholds	3.33
Height of couplers	1.22
Steps	.52
Ladders	1.07
Running boards	1.92
Hand brakes	4.89
Safety railings	.02
Footboards	.16
Pilot beam sill steps	.02
Handrails	.02
Steps for headlights	.01
Power brakes	.004
Ash pans	.001
All classes	44.01

TABLE II.—Summary of the Results of Terminal Tests of Air Brakes from July 1, 1917, to June 30, 1918

Trains	1,017
Cars	30,701
Air cars	30,699
Non-air cars	2
Brakes cut out	323
Brakes that did not apply	1,431
Brakes that operated	28,945
Cars not controlled by air	1,756
Cars controlled by air	28,945
Percentage of cars controlled by air	94
Brakes with excessive piston travel	148

The receipt of cars in interchange with defective safety appliances has been one of the common mistakes of the carriers, under the erroneous belief that such cars could be handled to a repair point without liability for the penalty. There are several decisions holding that a defective car can only be moved for the purpose of repair by the carrier upon whose line it became defective, the most recent of which is by the Sixth Circuit Court of Appeals, in which it was held that the necessary effect of the clause "and such equipment shall have become defective or insecure while such car is being used by such carrier upon its line of railroad," as used in the proviso of section 4 of the act of 1910, is to limit the right of hauling a defective car for repairs, without penalty, to the carrier upon whose line of railroad the car was being used when the equipment became defective.

In this connection attention is directed to Circular No. 7 of the Division of Transportation of the United States Railroad Administration, a portion of which relates to the offering in interchange of cars having safety appliance defects, under which the law as interpreted by the various courts will be observed together with the elimination of the dangerous practice of offering defective equipment to connections, thereby insuring the maximum of safety in operation and at the same time expediting traffic.

It is as yet too early to express definitely the degree of success attained under General Order No. 8 of the Director General of Railroads, in comparison with the former method of instituting suit for the penalty for violations under the statute. Under the former system there was a double purpose served by prosecutions for the penalty, that of publicity in defending such suits and the disciplinary measures taken by the carrier to prevent subsequent cases being filed. On the other hand, the remedy at present is that of discipline of employees, which it is believed will be efficacious when promptly and justly administered. Great care, however, must be taken to place the responsibility on the proper party regardless of position, so as not to permit the shifting thereof from officials to employees or evasion in any manner.

In addition to their regular inspection work during the past fiscal year, our inspectors investigated 91 train accidents and assisted in conducting a number of tests of safety devices. One of these tests, that of the automatic straight air brake, required the services of 10 inspectors for a period of more than two months. During the past winter also 42 inspectors were employed from January 1 to March 14 in investigating for the Railroad Administration the serious congestion of railway traffic which prevailed during that period. Performance of this special work will account for the fewer number of cars inspected shown in this report than is shown in the last annual report of this bureau. In the performance of all the exacting duties imposed upon them, our inspectors have displayed marked ability and have fully maintained the high standard of excellence which has always characterized their work.

INVESTIGATION OF SAFETY DEVICES

During the year plans of 88 devices were presented for consideration; 93 devices were examined and opinions thereon transmitted to the proprietors. Of the number examined, 74 were so impracticable or crude that they were considered worthless; 10 were devices which were not intended primarily to promote safety and which would not affect the safety of railway operation sufficiently to warrant further consideration; 3 possessed meritorious features, but as a whole required further development before being entitled to serious consideration; and 6 possessed merit as safety devices warranting some degree of commendation. Of the devices examined which were commended, two were hand-brake devices, one was an air-brake attachment, one was an automatic connector, one was a water sprinkler for locomotives, and one was a door for box cars.

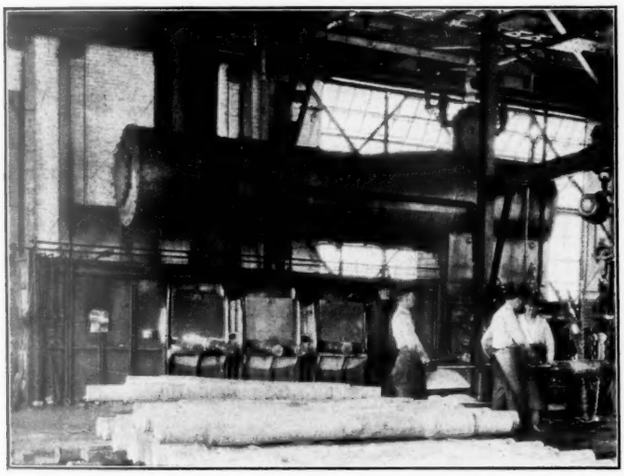
The automatic straight air-brake system mentioned in last year's report, which was submitted by the Automatic Straight Air Brake Co., New York, has been subjected to thorough tests during the year. The brake apparatus was first installed on a 100-car test rack in New York City and an elaborate series of tests was made. These tests demonstrated that the apparatus was sufficiently developed to warrant its trial under service conditions on a road having heavy traffic and mountain grades, and after the rack tests had been completed the brake apparatus was installed on 100 steel hopper cars on the Virginian Railway. These cars were loaded with coal. Standing and running tests were made with trains of 50 cars and 100 cars each, various arrangements of cars equipped with the present types of brakes and the new brake apparatus being used in these trains.

The purpose of these tests was twofold; namely, to determine whether the automatic straight air-brake apparatus would operate synchronously with brake apparatus in common use and to determine whether the new brake could be depended upon properly to control long trains on heavy grades as well as in general service. In these tests synchronous action with brake apparatus now in common use was obtained under a number of varied conditions and circumstances, and the flexibility of the system in controlling long trains, as well as smooth operation and the absence of severe shocks, were amply demonstrated. Many of the intended functions of the brake were substantially accomplished. The more important of these are (1) providing uniform brake cylinder pressure, irrespective of piston travel; (2) compensating for brake cylinder and brake pipe leaks; (3) greater availability of the emergency feature; (4) a graduated release feature, permitting flexibility of control; (5) prompt serial action in application and in release.

SHOP PRACTICE

UTILIZATION OF WASTE HEAT FROM BLACKSMITH FURNACES

No one who has been around blacksmith shops can have failed to notice the flames from the furnaces rising out of the stacks. This is such a familiar sight that it is taken as a matter of course: but on second thought it is quite evident that the flames must carry away a great deal of heat that has never been utilized. At the same time that this heat is going to waste, fuel is being burned in some adjacent power plant to furnish steam for hammers, shears and blowers in the

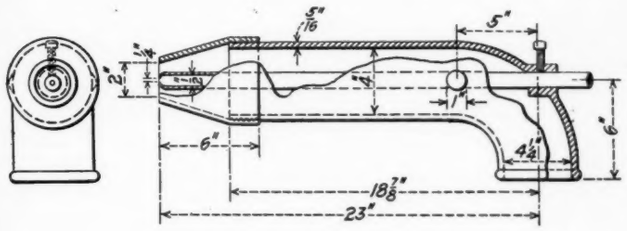


Locomotive Boiler Set Over Furnace to Supply Steam to Hammers

blacksmith shop. When there is such urgent need for fuel economy, why would it not be well to utilize the heat of the furnaces to generate steam for the smith shops?

This is by no means a new idea. Boilers mounted over furnaces are to be found in shops built many years ago. Topeka, Kan. In these shops the heat from the furnaces is used to generate steam in locomotive boilers which supply the steam hammers and also a few steam-driven tools. In the interest of fuel economy in railroad shops, a description of the plant may not be out of place.

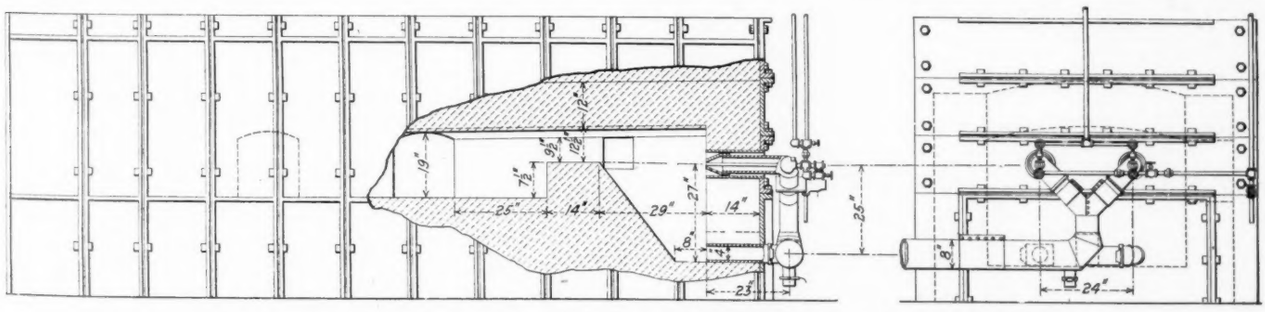
The furnaces over which the boilers are placed burn fuel oil. They are equipped with combustion chambers and the furnace proper varies from 8 ft. to 12 ft. in length. A view of the cross-section of the furnace is shown in the illustration. The oil is sent in through two burners in the end under a pressure of about 12 oz. from a fan blast. An auxiliary air supply enters the combustion chamber just below the burners. These burners are also fitted with steam jets which can be used to atomize the oil in case the air supply fails. As an alternative the furnaces can be readily



Detail of the Furnace Nozzle

and quickly changed to burn coal. Several features of this furnace are covered by a patent issued to George Fraser, foreman of the blacksmith shop.

The flames from the burner strike directly on the point of the bridge wall of the combustion chamber. This has proved to be a great help in securing a neutral flame. If there is any tendency for carbon to deposit it gathers on the brick-work and not on the iron. After passing down through the neck of the furnace the flame is directed upward into the firebox of the locomotive boiler, through the flues and out



Arrangement of the Furnace, the Waste Heat of Which Is Used for Generating Steam

The very limited extent to which this practice has been followed in shops recently constructed might lead to the conclusion that it has proved a failure. That such is not the case is fully demonstrated by the operation of the two blacksmith shops of the Atchison, Topeka & Santa Fe at the stack. The photograph below shows clearly the way in which the boilers are mounted over the furnaces. Very few changes were made in the boilers to adapt them for this service. They are fed by boiler feed pumps operated by the hammer driver who watches the water level to see that it

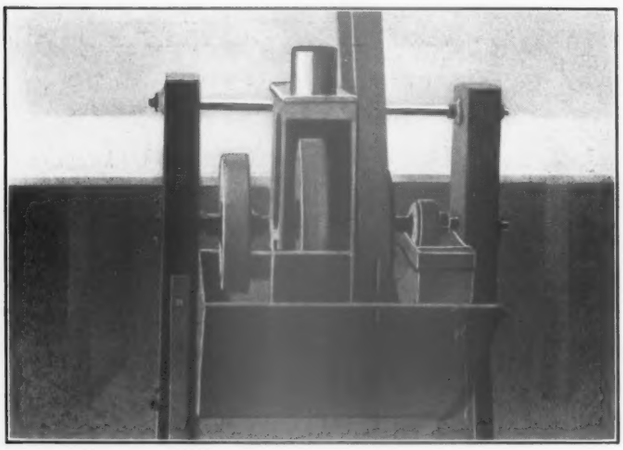
does not get too low. The water glass is situated so that it is always in view of the hammer operator. Steam is taken from the highest point in the dome. All the boilers are connected together; the maximum pressure carried is 100 lb. per sq. in. It ranges generally between 75 and 85 lb. The stacks over the boiler are 75 ft. high without brick lining and have a damper near the smoke box instead of at the top of the stack. In operating the furnaces the blast is varied until a balanced draft condition is secured. This makes it easy to work around the furnace as the flame does not shoot out and work can be put in or taken out without disturbing the burners.

In the blacksmith shop at Topeka there are seven boilers placed over furnaces. These supply steam for 17 hammers, varying in size from 5,000 lb. to 150 lb. There is no other source of steam supply for the smith shop. While, of course, some of the small furnaces are not fitted with boilers or stacks, all of the larger ones are so equipped. The operation is very satisfactory and there is no question that the plant effects large savings in both fuel and money.

RECLAIMING BULL'S-EYE LUBRICATOR GLASSES

After lubricator glasses have been in service for some time the inner surface becomes rough and discolored. A glass in this condition causes difficulty in seeing the oil as it is fed. The Atchison, Topeka & Santa Fe has installed at the Topeka shops equipment for regrinding these glasses to avoid the necessity of replacing them when they become rough. The installation has now been in service for some time and the results secured are very satisfactory.

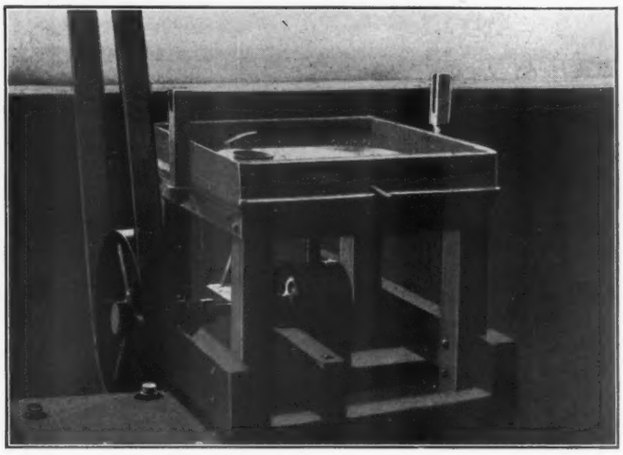
The machines used are quite simple and are shown in the illustrations below. The first grinding is done on a flat cast iron disk about 19 in. in diameter mounted on a vertical



Stone, Felt and Wood Wheels on Which Glasses Are Polished

spindle which revolves at the rate of 200 r. p. m. Sharp sand and water are used on this disk as an abrasive and the glass is ground down until a true surface is secured. A set of three wheels mounted on a single spindle are used for the finished grinding. The first wheel is a black cragleith stone which gives the glasses a smooth finish. The polishing is done on a felt buffing wheel and a willow wood wheel on both of which pumice stone and water are used. The three wheels revolve at about 350 r. p. m.

Glasses which have been scratched or chipped can be reground as well as those that have become roughened or discolored by use. They cannot be ground down below a certain thickness, which is about one inch; for that reason, limit gages are used to determine when the minimum allowable thickness has been reached. In shipping the glasses to the shop where they are to be reclaimed they should be packed in an orderly manner in boxes filled with sawdust. The machines used in reclaiming lubricator glasses are simple and comparatively inexpensive. It does not require



Machine for Rough Grinding Glasses

a very skilled operator to secure good results, and the saving effected at the present price of material is sufficient to justify such an installation on any road operating several hundred locomotives.

LOADING AND GLAZING OF GRINDING WHEELS

In replying to a question as to the relation of the speed of grinding wheels to "loading" and "glazing" Chas. H. Norton writes in "Grits and Grinds" as follows:

Loading is not caused *by* slow speed. It can be caused *with* high speed as well as *with* slow speed, but *is not caused by the speed.* If the wheel is forced into the work so deep and so quick that the material to be ground is crowded into the open spaces, filling them full before the bond can be worn away by friction, the wheel will be loaded, whatever its speed. But in practice it is usually impossible to cause this when the wheel is revolving at high speed, because the higher speed cuts smaller chips when removing an equal amount of metal in the same time. However, it sometimes happens that there is insufficient power to keep the wheel up to its full speed when the operator forces it quickly into the work; it will sometimes be slow enough to cause the particles to tear off chips so large that when they are forced hard into the spaces they will hold the bond in place instead of wearing the bond away.

If the chips are too large for the spaces and are forced into them, the bond cannot wear away because the chips have become the wearing surface, and until these chips are removed the bond must remain, since it is underneath the chips. This is a well known law with files and milling cutters. If a file is forced to the work too hard, it will fill with steel; the same is true of milling cutters.

The cause of wheel loading is not slow speed but *overwork,* whatever the speed. It is more difficult to overwork the wheel at high speed than at slow speed. Therefore, it is more unusual. When wheels are not overworked the slower the speed the faster the bond will wear away. The faster the wheel speed, when not overworked, the slower the bond will wear away and the longer the cutting particles will remain intact. Thus, when the speed is sufficiently high to cause the cutting particles to wear faster than the bond, we get the glazing effect.

SAFEGUARDS IN RAILROAD SHOPS

A Description of Some of the Safety Devices Used at the Various Shops of the Southern Pacific

BY FRANK A. STANLEY

THE application of safeguards for workmen in railroad repair shops involves some elements of difficulty not commonly attached to the installation of safety devices in the general machine plant and factory. In the first place, there is an essential difference in the character of the equipment as a whole in the two classes of establishments referred to and there is, further, an equally important difference in the general method of installation due of course to the peculiarities of the work conducted therein. The recognition now for some years given to the necessity for suitable guards for machine tools and other apparatus has led the builders of this equipment to incorporate many such devices in the

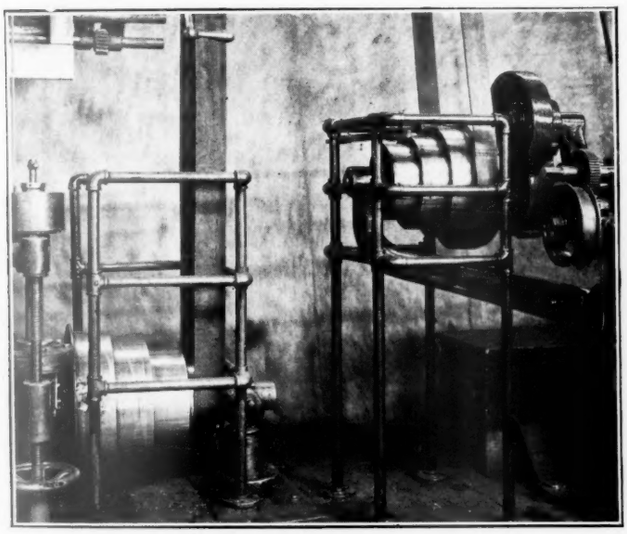


Fig. 1—Pipe Railing for Protecting Belts

design of the machines themselves thus doing away with the necessity for the purchaser to develop a system of safeguards for such equipment. This advance in tool design is naturally more conspicuous in the cases of the smaller and medium sizes of machines.

With the railroad shop the machine shop proper is only one of several departments where closest attention is constantly demanded if workmen are to be kept free from injury. The erecting floor may be a prolific source of danger unless progressive measures are applied toward protecting the men working about the pits and elsewhere in the department. Outside of the shops, about the yards are various points where safeguards must be erected and maintained, such as railings for washing pits, screens for work undergoing chipping, etc., etc. To be sure, the dangers to the eyes of mechanics about railroad shops is not peculiar to these places, but it does undoubtedly exist in greater degree than in almost any other kind of plant, a fact that has been demonstrated by the necessity for eye protecting goggles in large numbers. These, where consistently adopted, have gone far toward the complete elimination of eye accidents. This can be no better illustrated than by reference to the experience of a conspicuous eastern repair shop which in one recent year prior to the campaign for the adoption of eye protective measures suffered a total of over four thousand injuries of varying degree, which the following year were reduced almost to zero by the adoption of goggles which the men were forced to wear when working at points of danger to the eye.

WHAT ONE SYSTEM IS DOING

Certain characteristic features of the Safety First campaign in the way of safeguards developed and adopted in different shops of the Southern Pacific are shown in the illustrations that follow. These include machine guards, for shop and wood working departments, yard safety devices, appliances for minimizing possibilities of accidents about the erecting pits, and so on.

The guards in Fig. 1 are for enclosing the driving belts and pulleys of two machines; the one at the right a shaper, the other a vertical boring mill. In both instances the railing is made of piping extending to a height that will effectively prevent any likelihood of a passing workman catching his clothing in either the belts or pulleys. The pipe enclosures are stiffly constructed and with machines placed with their driving cones and belts in fairly close position in respect to each other this form of guard is of especial ad-

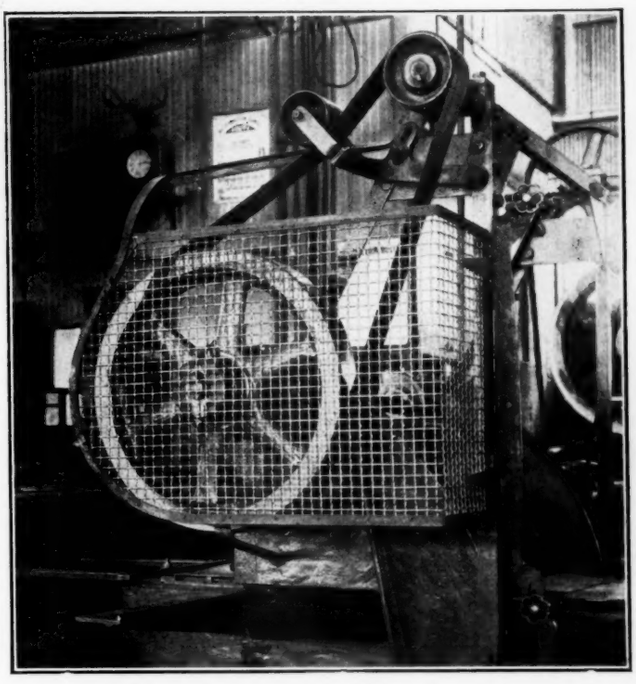


Fig. 2—Hinged Guard for the Fly Wheel of Copper Shop Shears

vantage as it in no way interferes with the convenient shifting of belts on pulleys.

The guard in Fig. 2 is a hinged screen for the flywheel and driving belt of a shear in the copper shop. A guard of similar pattern is used over the pulley of the sprue shears used in the brass foundry. Another foundry guard is shown in Fig. 3 which shows a row of grinding wheels ten or a dozen in number, all protected by heavy plate covers which nearly surround the wheels. The frequency of serious accidents from unguarded wheels is too well known to require

discussion here. The type of guard shown prevents broken wheels from flying across the shop and while protecting the workman from injury it in no way hampers his use of the wheel. Wheel covers of this kind are readily made in such shops from available material and they are easily proportioned to conform to the dimensions of the grinding wheels employed on the floor stands.

Special guards are erected on heavy lathes for enclosing

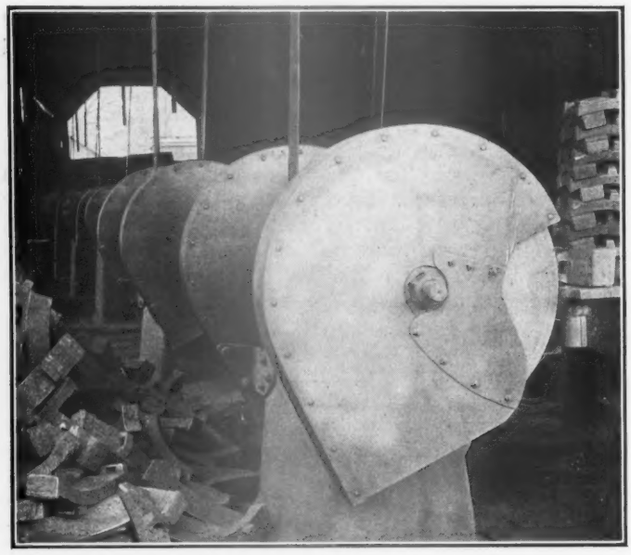


Fig. 3—Guards for Grinding Wheels

the feed drive at the end of the bed and the back gears at the rear of the spindle. The end guards are made up of a coarse wire screen riveted to a steel angle frame which is of sufficient size to extend from the base to the top of the head stock. The sides of the guard are wide enough to completely

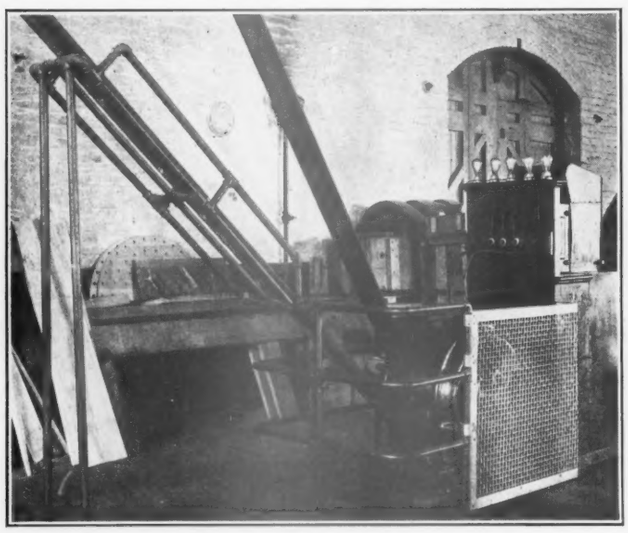


Fig. 4—Protected Motor and Belt in the Pattern Shop

close in the feed cone and belt at the front and there is no possible way in which the operator's hands or clothing may become caught in the mechanism. The guard for the back gearing is made of sheet steel covering completely the gear teeth and extending well down over the faces of the gear wheels. Both guards are hinged to give ready access to the interior when desired.

In order to properly protect the operator from being injured by the rapidly revolving bar stock extending out from the spindle of turret lathes, a system of small pipe guards has been arranged. There are six longitudinal rails extending out from the machine, being supported by pipe standards from the floor, which completely surround the revolving rod.

APPLICATIONS IN WOODWORKING DEPARTMENTS

Referring now to some of the protective devices installed in the woodworking shops, Fig. 4 illustrates the application

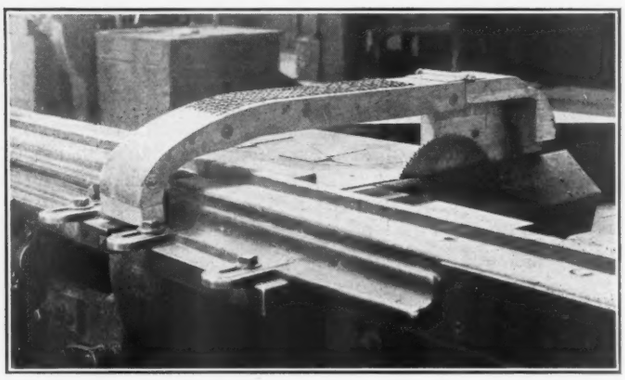


Fig. 5—Draw Cut Saw Guard in the Cabinet Shop

of a guard rail system and swinging screen gate for enclosing a motor and belt in the pattern shop. The belt here is run at an angle of about 45 deg. to the overhead shafting, and in

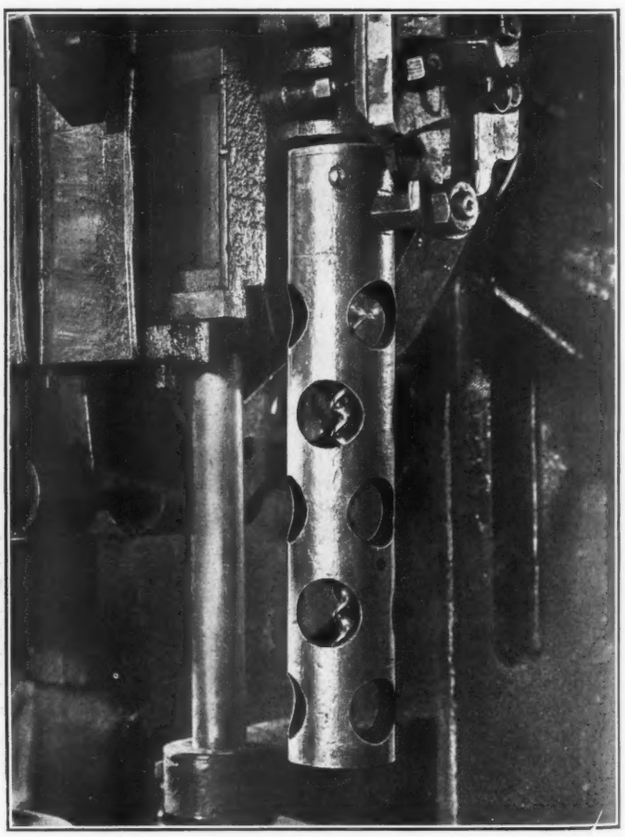


Fig. 6—Wood Boring Bit Guard

this position, if unguarded, it would be a constant menace to those obliged to pass under it. The lower portion of the belt is surrounded by the high pipe fence which is built around the

motor. The remainder of the belt for a height of, say, seven feet is paralleled by a sloping guard which just clears the underside of the belt and which has at each side a pair of rails to provide protection along the belt edges. The enclosure

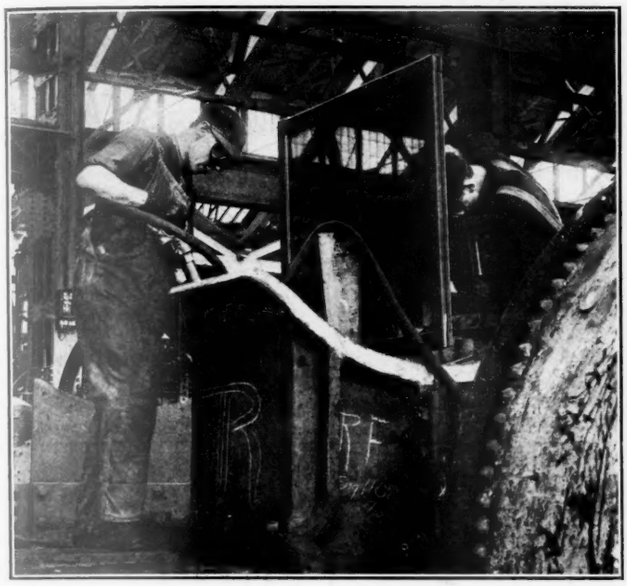


Fig. 7—Protecting Screen Between Men Clipping Cylinder Saddles. Note Also the Goggles

for the motor itself is formed on the front side by the wire gate which swings open when unlocked to give access to the machine.

Saw guards are generally provided and require little explanation. Fig. 5 shows a guard for a circular saw in the cabinet shop. Another feature of this department is the use of a rubber mat in front of the saw which is placed here to prevent the workman from slipping while he is operating the saw.

An interesting form of guard for a wood bit used in the mill shop is shown in Fig. 6. This safety appliance consists of a steel tube containing a number of holes through which the chips may work out when boring. The tube is located over the spindle which carries the bit and is attached to a bracket by which it is prevented from rotating, and by which it is moved up and down. It encloses the bit at all times, and when the bit is at work boring through the wood the chips are ejected from the tube through the liberally placed holes shown in the illustration.

SAFEGUARDS ABOUT THE ERECTING FLOOR

Reference has already been made to the necessity for protective goggles in railroad shops. A still further measure of protection, and one almost as valuable as the goggles themselves is the adoption of the portable wire screen which, as in Fig. 7, is placed at any convenient point to prevent chips made by one man from striking another nearby. This scheme can be developed further in the yard where chipping or cutting rivet or bolt heads is done, by making a portable screen with a substantial base which will prevent the chips or heads from flying about. Still another device used for stopping metal parts that would otherwise fly to a considerable dis-

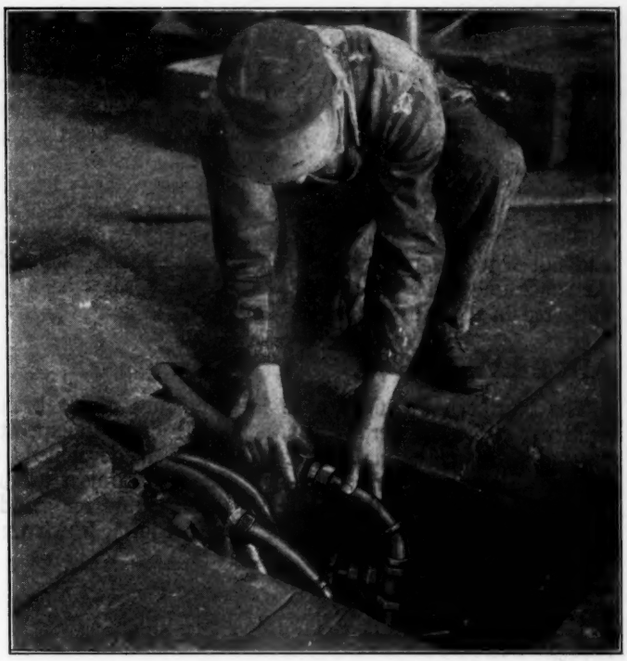


Fig. 8—Pipe Connections Placed at an Angle Away from the Operator When Making Connections

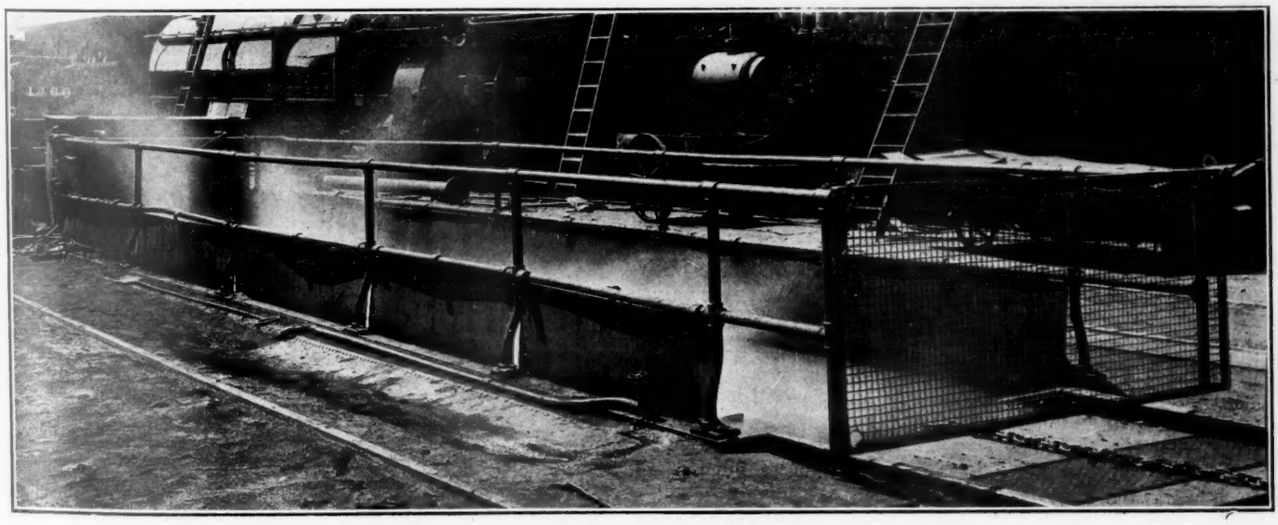


Fig. 9—Safety Railing Around the Lye Pit

tance is the wire basket which is held under rivet heads which are being cut off by hand chisel and sledge.

One of the unsatisfactory features of many erecting floors is the system (or lack of system) of steps, ladders and stagings for enabling the men to climb about the ends and tops of boilers and fireboxes. Not only are the makeshift rigs often dangerous to those obliged to use them, but they are to an equal extent the cause of lost time and effort. In this shop a portable stairway which is a substantial and reliable structure, has proved very effective in saving time and trouble. It is equally applicable to the front, end or sides of the locomotive.

Another interesting safety measure adopted at this shop is that, as shown in Fig. 8, of setting the floor hose connections at an angle so that they do not blow directly in the face of the operator when connections are being made.

Fig. 9 shows a substantial safeguard for a large lye pit. This has, in addition to the two-high pipe rail an end gate which swings open to allow the dipping cars to be run in and out with the material to be washed. Along each side the space under the lower rail is enclosed by sheet metal as indicated in the illustration.

AIR BRAKE DEVICES AT BRAINERD SHOPS

The Northern Pacific does a large amount of air brake repairing at the Brainerd, Minn., shops. In order to expedite the work, many special devices have been developed, a few of which are described below. One of the most useful tools in the air brake department is the machine for grinding the bushings of triple valves shown in Fig. 1, which was

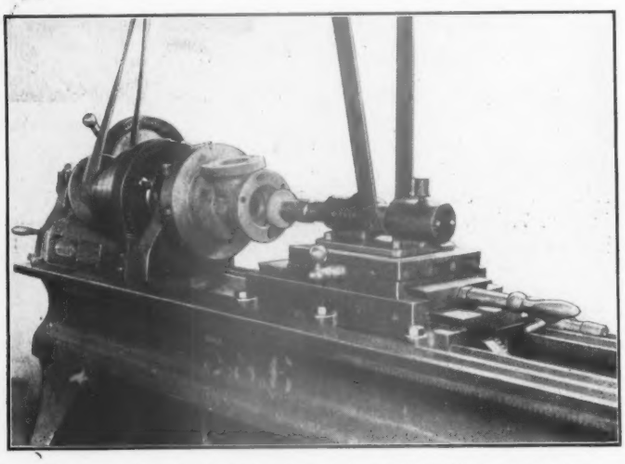


Fig. 1—Lathe Arranged for Grinding Triple Valve Bushings

made from an old brass lathe. In ordinary service the pistons of triple valves move principally between service and release positions and this causes the ring to wear the bushing through a small portion of its length. When triple valves are repaired at Brainerd shops the bushings are ground on this machine to make them truly cylindrical. The body of the valve is attached to a removable face plate which can be centered by means of screws. The grinding wheel is mounted on an extended spindle, carried on the cross slide and driven from an overhead counter shaft. By centering the bushing, setting the wheel to take a light cut, and moving it back and forth while the body is slowly revolved, the bushing can be made true and smooth without removing any more metal than is necessary. By changing face plates the machine can be adapted to any type of lathe. The uneven wear of bushings is the frequent cause of irregular action in triple valves and a machine for grinding them should form part of the equipment at least in the larger shops.

Another useful device for repairing triple valves is a press for closing the grooves in the piston shown in Fig. 2. The base is made of cast iron with a hole through the center and a counter-bored recess at the top. The bottom die is placed in the recess and the piston is set on it with the stem extend-

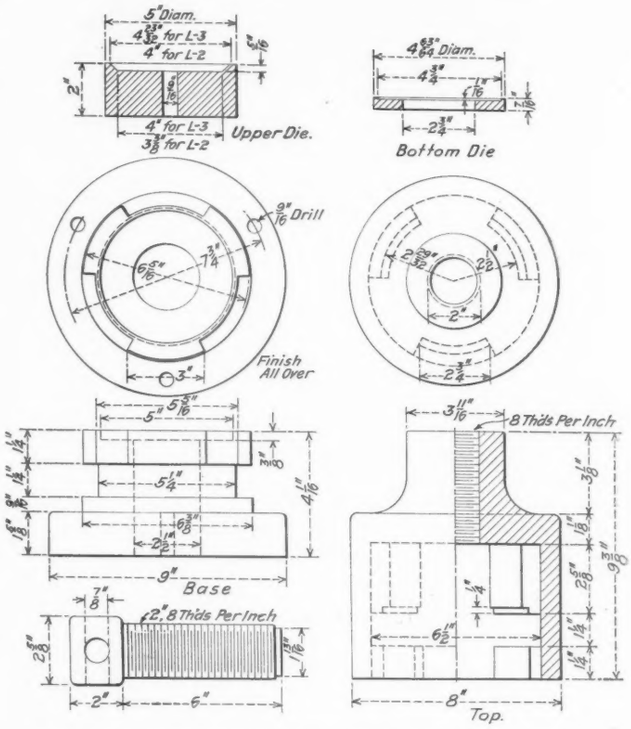


Fig. 2.—Press for Closing Triple Valve Piston Ring Grooves

ing down into the base. The upper die is placed on the piston and the top is set over it and turned to lock it to the lugs on the base. By turning down the screw in the top the

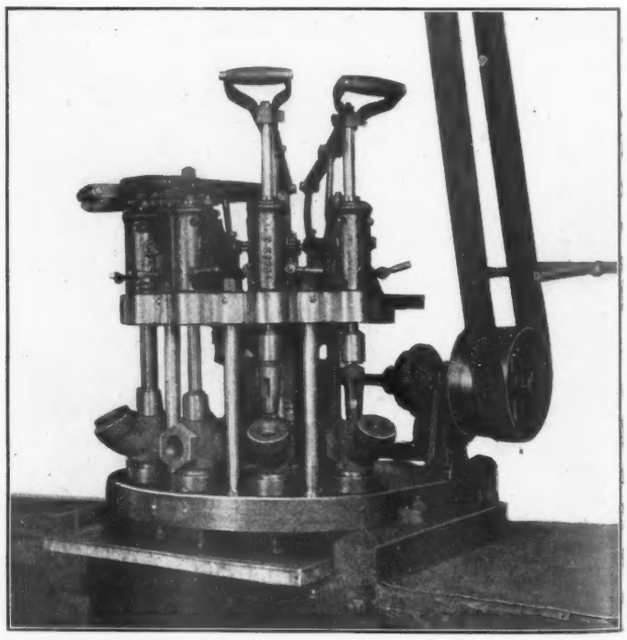


Fig. 3—Five Spindle Angle Cock Grinding Machine

piston can be compressed and the grooves closed. It has been found that the operator soon becomes skilled in using this device so he can get a good fit in a very short time. The dies

shown in the illustration are the sizes used for *L*-2 and *L*-3 triple valves.

The angle cock grinding machine shown in Fig. 3 was originated on the Northern Pacific. It is convenient to operate and grinds the cocks very rapidly. The plugs are fastened to five vertical spindles which are revolved and reversed by a segmental gear. At the same time a trip lifts the plug from the body at regular intervals. The spindle can be raised by means of a handle and when at the top point it is thrown out of gear and held by a latch so that the bodies and plugs can be changed without stopping all the spindles. One of the excellent features of this machine is that the grinding compound is kept away from the gears and bearings. As many as 300 angle cocks have been ground in one day.

OXY-ACETYLENE WELDING PROBLEMS*

Discussion of the Flame Structure and Methods of Handling; Careful Training of Operators Necessary

BY W. L. BEAN
Mechanical Assistant, New York, New Haven & Hartford

IT is my desire to present certain phases of the oxy-acetylene process which may have escaped the attention of those who have not had opportunity to study it in all its details. The use of the process in railroad work alone has grown since 1912 fully 25 times in volume. Methods of handling and applying oxy-acetylene in railroad work should, however, be scrutinized and properly supervised if the results are to match up with the rapidly mounting expenditures necessary daily, and monthly, and yearly to carry on the work. Since the process depends on two gases, acetylene and oxygen, a few facts, with respect to each, may be mentioned, I trust, with interest and profit.

ACETYLENE

Acetylene, which, as is known by all, is generated by chemical reaction between water and calcium carbide, is a gas of remarkable qualities. Briefly, its most outstanding characteristic, and the one which puts it head and shoulders above all other commercial gases, is its high carbon content which is 92.2 per cent of its total weight, and which gives such a high flame temperature, especially when burned with pure oxygen. Furthermore, the endothermic nature of acetylene further increases the flame temperature.

It is this characteristic which prevents the common gases, such as ordinary illuminating gas, natural gas, benzine, gasoline, kerosene, Pintsch and Blau gases, etc., from competing with acetylene for welding any metals, but those with low fusing temperatures; and from cutting steel or iron with the greatest economy. Comparative temperatures attained by burning acetylene and other fuels supplied by air are shown by the tabulation below:

FUEL GAS FLAME—TEMPERATURE IN AIR

Alcohol	3,092 deg. F.
Marsh gas	3,362 deg. F.
Hydrogen	3,452 deg. F.
Coal gas	3,542 deg. F.
Water gas	3,632 deg. F.
Acetylene	4,652 deg. F.

Naturally when flames are supported by oxygen instead of air, the temperatures attained are much higher. This is of interest because it is sometimes difficult for those in charge of oxy-acetylene work to understand why it is necessary to use oxygen instead of air for welding work:

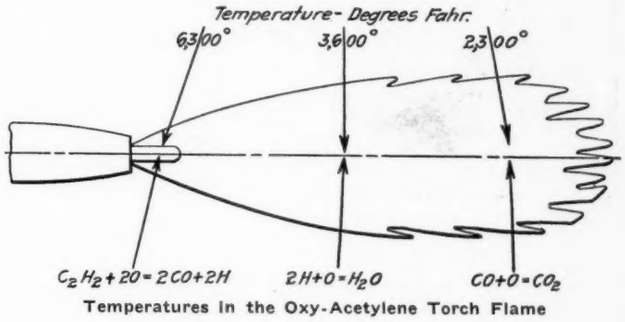
Coal gas burned in oxygen	3,960 deg. F.
Hydrogen burned in oxygen	4,388 deg. F.
Acetylene burned in oxygen	6,300 deg. F.

It is to be noted that acetylene burned in air gives a higher flame temperature than either coal gas or hydrogen burned in oxygen. My object in bringing up this subject of flame temperatures is to show that a welder handling a blowpipe has an extremely hot flame to handle; a temperature that is a good deal higher than the fusing point of the metal that he is handling. Consequently it indicates the amount of skill an operator must have to properly fuse these metals without burning them.

These facts explain why the oxy-acetylene blowpipe has so successfully met all competition offered by other devices using gases whose combustion results in lower flame temperatures. Other factors in regard to the oxy-acetylene flame may be mentioned, and the following is of interest.

THE WELDING FLAME

The oxy-acetylene welding flame is composed of two portions; the small inner so-called cone, which attains a temperature of approximately 6,300 deg. F., is produced by the combustion of oxygen supplied to the blowpipe, uniting with the carbon from the acetylene. The products of this initial combustion are free hydrogen and carbon monoxide. The temperature supplied by the cone is too great to permit combustion of these two gases until they have cooled off. Therefore, they pass out from the cone until they meet the atmosphere, where they cool and unite with atmospheric oxygen, to form water vapor and carbon dioxide, respectively. The burning of



Temperatures In the Oxy-Acetylene Torch Flame

the hydrogen to create water vapor is at about 3,600 deg. F., and the carbon monoxide burns forming carbon dioxide at about 2,300 deg. F. That is of particular importance in welding alloys or metals like copper, which oxidize pretty rapidly, and it is one feature that stands out in favor of the oxy-acetylene flame as compared with the electric process, for although the electric process has the advantage of generating a great deal less heat—and thus reducing contraction stresses—the metal is not protected from the atmospheric oxygen as it is with the oxy-acetylene flame. The outer, cooler, enveloping flame acts as a shroud, which keeps the atmospheric oxygen from uniting with the metals being welded, thereby performing a valuable work. The products of the combustion, which forms the cone, hydrogen and carbon

*Abstract of a paper presented before the New England Railroad Club.

monoxide have strong affinities for oxygen, thereby assisting in preventing any excess of oxygen from uniting with the metals.

These features all contribute to making the oxy-acetylene blowpipe the wonderful device that it is, and the subject of flame temperatures is dwelt upon here with the practical consideration always in mind that the successful operator and his supervisor should know these elementary things in order to properly handle their work. If the operator does not know them, he will, with the best of intentions, spoil or render inferior most of his welds, and his supervisor may stand by and watch and not know what is going on because he cannot recognize what he is looking at. Examination of hundreds of test specimens and likewise hundreds of observations of welding operations convincingly shows that the great majority of blowpipe operators underheat the body metal; that is to say, the piece being welded, and, on the contrary, they overheat the wire or filler metal. An operator who plays the small cone directly on the filler wire is burning it. He cannot do otherwise. Such a workman invariably runs the burnt metal upon the underheated surface of the piece he is trying to weld, and gets an adhesion, but not a weld. He has, as a result, a combination of two weak elements; viz., burned metal attached by surface adhesion to the body metal.

This point cannot be too strongly emphasized, as it is the cause of more inferior welds than any other one thing. The skilled operator works the end of his filler wire in a puddle of the metal, agitating the molten metal and thereby distributing the heat. Also, he constantly moves his welding cone so as not to overheat the molten metal and so as to permit moving the wire through the latter without the wire encountering the welding jet. The welding cone should approximate, in its movements, a half circular arc. The welding wire should be melted by heat from the puddled metal plus radiated heat from the cone, but never by being enveloped by the latter. The function of the acetylene in cutting, being merely to raise the metal to the temperature where the oxygen can take hold of it, has led a good many to attempt to use as a substitute a cheaper gas than acetylene, but because of the high flame temperature of the acetylene—consequently the ability to localize the heat in a relatively small jet—there is really more economy in paying the higher price for acetylene—that is, economy in oxygen—than there is in using other fuel gases, even though the other gases cost nothing.

OXYGEN

The development of the oxy-acetylene process was retarded by the high price of oxygen. In 1910 oxygen was commonly sold at from four to six cents per cubic foot and still largely produced by the potassium chlorate process. The big possibilities commercially, however, stimulated production and a cheaper chemical process using bleach powder and some other reagents had a short life, the cost being about 2½ cents per cubic foot. The electrolytic and liquid air processes, however, control the market at present and are likely to continue, especially the latter. In 1912 the price of oxygen had dropped to about 2 to 2¼ cents per cubic foot, in quantities, and now most railroads buy it for 1½ cents or slightly less. Therefore, it is one article of importance which has decreased in price during the period of the war, and, as it is the item of largest expense in welding, especially in cutting operations, railroads have a better opportunity than ever before to make large and profitable utility of the process. It is true that carbide has increased in price, and so has labor, but not more than like items entering into costs of doing work or reclaiming materials by other methods.

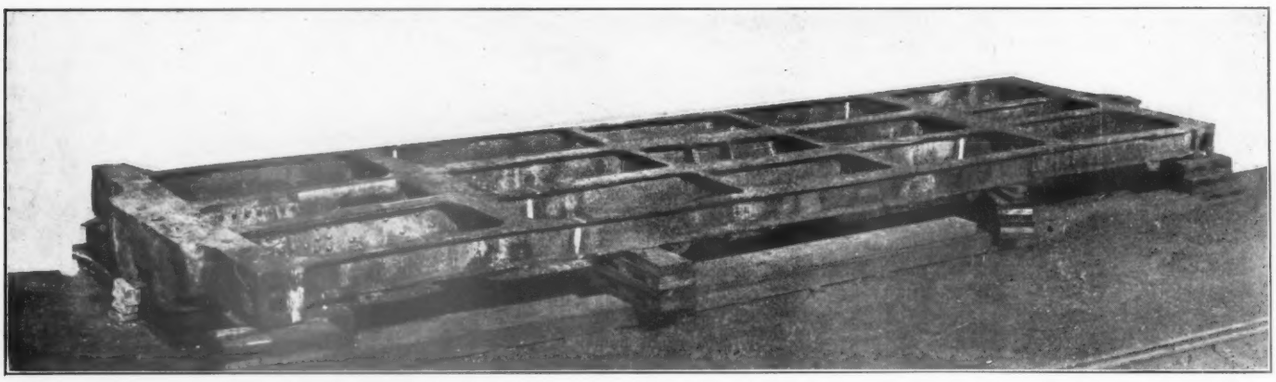
APPARATUS SELECTION

Naturally with the development of the process there comes opportunity for refinement in the selection of apparatus to suit given conditions and the ultimate results depend on the choice made.

For oxy-acetylene operations in small shops or for temporary work at remote points, compressed acetylene in portable cylinders is best adapted to the work; but in large shops, where a relatively large amount of work is done regularly within a restricted area, full advantage should be taken of the economies of stationary apparatus connected to a piped system. Experience indicates that railroad shop installations of oxy-acetylene equipment should consist of stationary instead of portable apparatus when the volume of welding and cutting requires the services of two or more operators regularly.

Compressed acetylene costs 1½ to 2 cents per cubic foot, f. o. b. charging station. Freight or express charges must be borne by the railroad both on the filled and the empty drums, whereas, in using a generator, the cost per cubic foot is ¾ to 1 cent per cubic foot, depending on carbide price, and there is no expense for transportation except in one direction, and also there is less weight to be handled per foot of gas delivered by the generator as compared to the compressed acetylene. Also the slowness of releasing the compressed, or dissolved gas, especially on heavy work, causes operators to set cylinders aside as empty when they still retain from 10 to 20 per cent of the *nominal gas charge.* This is especially true in cold weather. This feature, of course, raises the cost of the gas per actual cubic foot delivered to the blowpipe. The cost is also affected by the admixture of varying amounts of acetone to the discharged gas.

Acetone, by reducing the flame temperature, requires the burning of more acetylene to do a given amount of welding

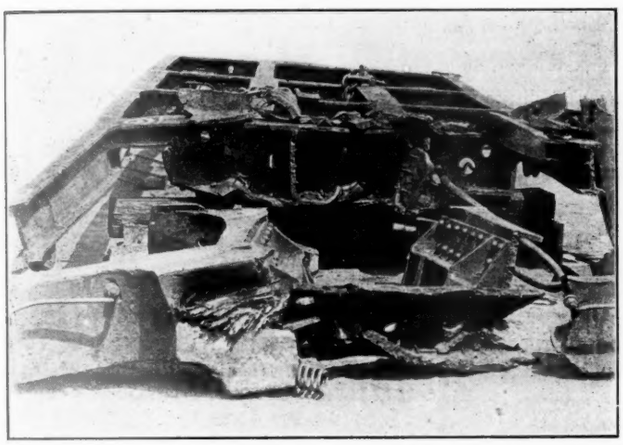


Repaired Cast Steel Tender Underframe

than is needed when acetylene, free from acetone, is taken directly from a generator. These several features combined produce an actual cost for compressed acetylene of 2½ to 3 cents per cubic foot.

Aside from the above considerations, there remains a number of matters concerning ease and efficiency of operation. When an acetylene generator is installed, it delivers a continuous supply of gas to a shop through a pipe line at a constant pressure, thereby eliminating the need of regulators or reducing valves which have the following disadvantages: First cost, maintenance cost, and the time required for adjusting pressure and for connecting and disconnecting from cylinders.

Under the constant supply system the operator is at once relieved of all concern as to gas supply, since the handling



A Wrecked Cast Steel Tender Underframe Repaired by Oxy-Acetylene Welding

of cylinders from the storehouse to the shop and back again, and from job to job, is eliminated. He is also not concerned with regulating the gas pressure, as that is done by the generator, and he need not, and, in fact, cannot, change the pressure. That cuts out the regulator expense and annoyance. In fact the operator has his hose and blowpipe and can move from job to job without any more apparatus to carry or adjust than in the case of a man using an air hammer supplied by a pipe line.

Blowpipes are carefully designed by manufacturers and should not be altered by railroad shop men. If orifices are changed the proportion of mixing of oxygen and acetylene is disturbed with consequent effect on combustion. In this connection it is important to point out the need for using gas pressures and welding and cutting nozzles suitable for the heaviness of the work done. The average railroad shop worker, and that includes foremen, generally assumes that if a little is good a whole lot more is better, and so, one can daily observe operators welding thin plates with cones big enough for a locomotive frame job, or cutting an ash pan sheet, with 75 lb. oxygen pressure instead of 25 lb. Likewise, in using a cutting blowpipe, too large nozzles are used. When one cuts a ⅜-in. plate with 75 lb. oxygen pressure and a nozzle to match that pressure, fully two-thirds of the oxygen is absolutely wasted and the cost increased at the rate of $4 to $6 per hour of operation. There is a lot of money being wasted in everybody's railroad shop, especially on cutting, by using nozzles and pressures that are too big for the job, and a lot of alleged savings that are going by the board on that account.

There must be education and real supervision along these lines, or else the volume of poor and at the same time expensive work cuts down the benefits deplorably, below what they should reasonably be. The average net savings in money, in ordinary locomotive and car shop work, should conservatively and easily average $1 per blowpipe hour.

Of course, not all jobs of work are, or should be done by oxy-acetylene, solely to secure a reduction in first cost. The better quality of a welded job with longer life and less trouble in service, may warrant spending more money welding it than to do it in some other way. For example, some shops can rivet firebox seams cheaper than to weld them, but they find it pays to weld. Hence, the back shop saving in money does not tell the whole story. Likewise, all are familiar with large savings in time consumed by repairs whereby equipment has been released for service more quickly than otherwise possible.

I would like to speak of a job that the men on the New Haven did this summer on a Commonwealth tender frame for a Santa Fe type engine. Just after those engines came one of them got into difficulty with another one, and when the dust had all settled there was about six or seven feet of each end of the Commonwealth frame that was pretty well pulverized. The frame was taken to the shop. I don't need to dilate on the possibilities of last June in getting a frame of that sort from the foundries—at East St. Louis, I believe they are. It looked as if that engine was going to be tied up for the rest of the summer. But the job of welding these broken members was tackled. In addition to the broken portions on the ends the balance of the frame had a nice gentle wave to it, just like a warped board, and you can all appreciate what a job it was to pull that thing back into line. It had to be done by cutting the members to limber it up enough, so that the balance could be bent and the frame straightened, and then these cuts rewelded. Such portions of the damaged ends as could, were rejoined one to the other, and in some places, where they were about the size of a piece of cake, we had to fill in with plates shaped to fit. As I recall, the job altogether took about six weeks' time, and it cost about the same as a new frame, but the engine was in service probably two or three months earlier than would otherwise have been possible, and so we felt it was worth while.

IMPORTANCE OF WELDING ACCESSORIES

Boilermakers know that it would be folly to build a fine locomotive in all particulars except the firebox, and then to make the latter out of tank steel, or to build the engine according to approved practice and then put in staybolts made of common merchant bar iron. Just as unwise is it to equip a shop with high-grade oxy-acetylene apparatus and then give welders common iron to use as "filler" metal, or to set them to welding a gray iron casting with scrap packing rings for "filler."

The different metal parts of a locomotive vary greatly in their chemical and physical characteristics, and likewise those characteristics usually change more or less when the metals are heated to a welding temperature. On that account "filler" metals and fluxes designed to produce metal in the weld as nearly as possible of the right make-up should be used.

Charcoal iron wire of great purity is best for firebox work, and no flux is needed, but it is not the best practice to weld a cast-steel mud ring with that metal, which has 48,000 lb. tensile strength, when the mud-ring steel probably has a strength of from 60,000 to 75,000 lb. per sq. in. Is it not better to use on such work a "filler" of proper carbon content to give the weld high tensile strength, and to be otherwise specially adapted to the work?

It is not sufficient to use a "filler" of the same grade as the metal to be welded, or to use one which might seem even better in quality than the object to be welded. For example, any cast iron to be found on a locomotive, no matter how good it may be for the purpose it was made, does not make a good "filler" on a casting where it is important to get a clean, strong weld, which works well under a tool. The

reason is, that on cast iron work a special alloy "filler" iron containing from three to four times as much silicon as is found in ordinary foundry castings, is needed. The excess silicon replaces that of the welded casting, oxidized in the making of the weld, and since the silicon controls, to a large extent, the proportion of combined and free carbon in the casting, it cannot be removed without hardness resulting.

A great majority of railroad shops have generally indifferent results in welding cast iron, even where they use approved practices insofar as blowpipes, skillful welders, proper fillers and fluxes, etc., are concerned, because they don't take the proper care in preheating and annealing. It is necessary on a cylinder job, for instance, or any job of any magnitude, where the casting has any complication to it, or any great mass, to heat it slowly, and weld it, and then let it cool slowly. It may be necessary even to let the job stand for 48 or 60 hours covered up from the air to let it gradually cool down. If it is allowed to cool rapidly it will not only warp but it will be as hard as flint. I find that the foremen as a general rule are so anxious to hurry the job that they lose time or lose the weld by not being willing to let the men on the job take the requisite time to do it,—and I don't mean time in the welding itself but in getting ready and in letting the thing cool down slowly afterward. Oxy-acetylene welding, to be carried on with the best of success, must include the use of "fillers" and fluxes specially compounded to meet the needs of the different metals to be welded. This applies to all forms of iron and steel, forgings, plates, shapes and castings; and to copper, brass, and aluminum.

SELECTION AND INSTRUCTION OF WELDERS

The use of pure gases, efficient blowpipes, and proper fillers and fluxes does not insure good welds unless operators are competent. Probably more failures of welds have resulted from unskillful and unintelligent craftsmanship than from any other one cause.

Not all proposed operations of welding are possible or advisable, but when men of some mechanical skill and knowledge of the metals and the demands which service will place on the weld are given correct and sufficient instruction, a great variety of jobs can be done successfully from every standpoint. The principle that years of apprenticeship are necessary for the training of boilermakers or machinists, and but three days or a week should be ample for a welder, has prevailed in some quarters and does yet, although the logic is not clear, and surely is not borne out in practice.

Those railroad men who recognized at the start the value of the oxy-acetylene process and who persistently applied intelligence and ingenuity to the problems attending its use achieved much success, and to those men much credit is due for proving beyond argument, by long records of welds in service for years, that the process is peculiarly adaptable to locomotive and car repairs. Those gentlemen know what constitutes real welding, and what intelligence, skill, and practice is needed in the make-up of a good operator.

On account of the fact that results in welding are very largely dependent on the skill of the operator, and because the welds can vary even more in actual structure than in external appearance, it is necessary to place blowpipes in the hands of men who have a knowledge of the particular piece being welded, as to its physical nature and the service to which it is to be subjected. Moreover, men who can be successfully instructed in the elementary chemistry of the subject will have a finer appreciation of the need for careful blowpipe regulation, the preparation of the work, the use of fluxes, the application of suitable special filler materials, the effects of expansion and contraction, and all other details which have to do with the efficiency and economy of the operation.

Men who are intelligent, who take a natural pride in workmanship, who are uniform in disposition, who are anxious to become proficient, should be the ones entrusted with the blowpipe, and the additional wages which such men command will prove a most excellent investment.

LOCOMOTIVE ELECTRIC HEADLIGHT WIRING

An interesting and well-arranged method of wiring locomotives for electric headlights has been developed by the Pennsylvania Lines West in connection with the electric headlight program on that road. Every effort has been made to provide a system which is free from the possibility of short-circuits and which will occasion the least amount of trouble when a locomotive is being stripped for repairs. The generator is located just ahead of the cab, a steam connection being made from the blower line through the cab with a union joint just outside of the cab.

Three classes of service, namely, road, shuttle and yard service, are provided for. Fig. 1 shows the general arrangement of the wiring and fixtures for locomotives in shuttle and yard service. These are similar to the arrangement for locomotives in road service with the exception of the wiring to the tender, which is eliminated. Fig. 2 gives the wiring diagrams for the three classes of service. They are fundamentally the same. The diagram for locomotives in shuttle service is different from that of the diagram for locomotives in road service in that it provides for the headlight and classification lamps for the tender. The diagram for yard service is different from the diagram for shuttle service in that no dimmer resistance is required. The circuits are controlled by single-pole push

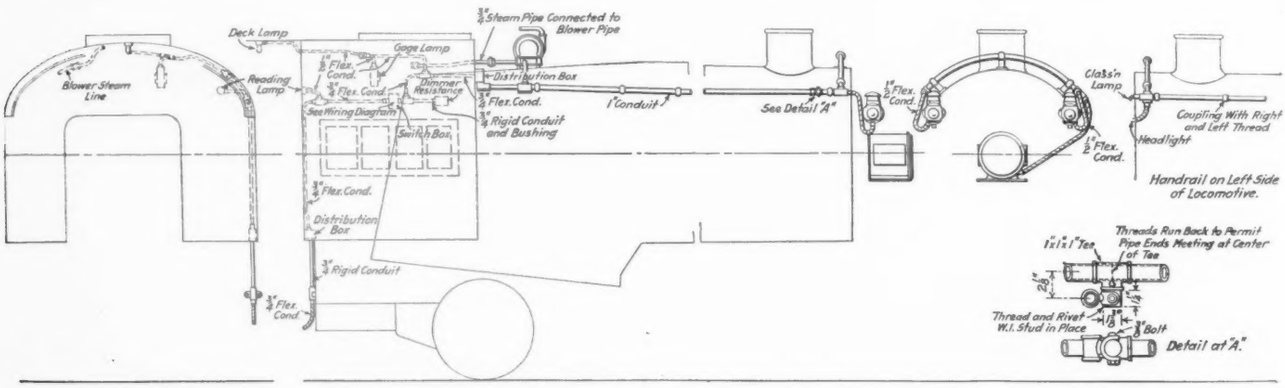


Fig. 1—General Arrangement of Headlight Wiring for Locomotives—Pennsylvania Lines West

button switches which are located on the side of the cab within easy reach of the engineer. For road service three switches are provided. The top one is the main operating

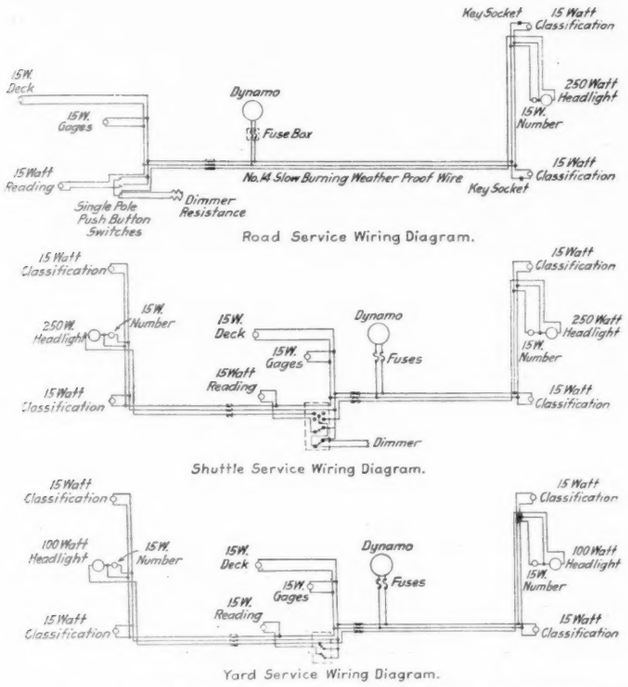


Fig. 2—Wiring Diagrams for the Three Classes of Service

switch energizing the entire system. The middle one governs the circuit to the reading lamp, which is located on the side of the cab back of the engineer. The lower switch throws the dimmer resistance in or out as required. This provides a very convenient arrangement and eliminates any possibility

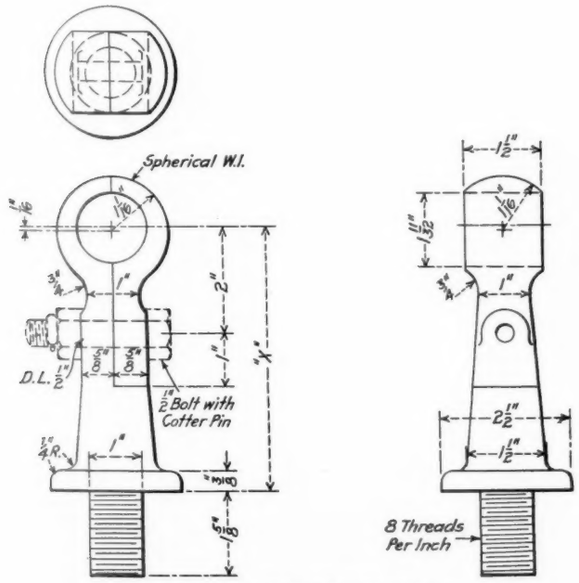


Fig. 3—Details of Hand Rail Column

of the headlight being thrown out of service by mistake when it is desired to cut in the dimmer resistance. It will be noted that a key socket is provided at the classification lamps. This is done for the purpose of insuring proper inspection of the lamps when it is necessary to turn the lights on or off. The deck and gage light, together with the headlight and number light are on the main circuit and are always lit whenever the circuit is closed. They are wired in parallel so that the failure of one light will not break the main circuit.

The wiring diagram for locomotives in shuttle service is substantially the same as that for road service with the exception that the main switch is of the "one-off, two-off electrolier" type, in order to require only one dimmer resistance

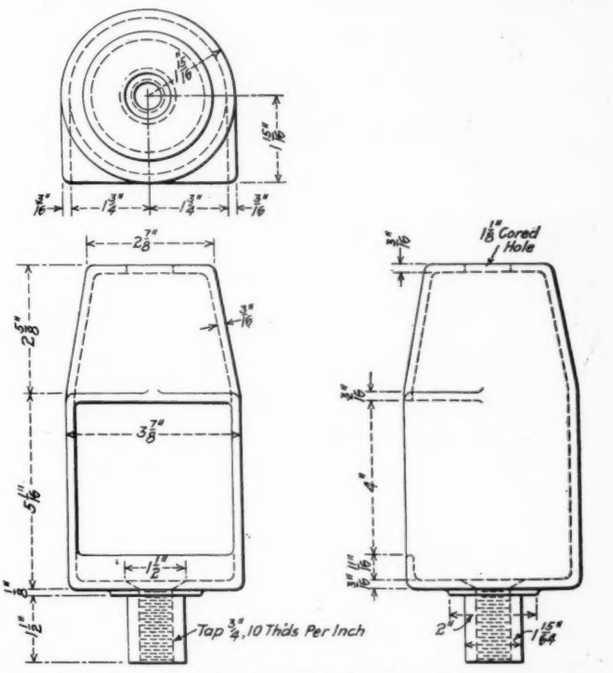


Fig. 4—Cab Lamp Used on Pennsylvania Lines West Locomotives

for both front and rear headlights and still permit them to be wired in parallel. The wiring diagram for locomotives in yard service is similar to that for shuttle service with the exception of the dimmer resistance, as headlights for this class of service are of less intensity than those for road service and no dimming of the light is required.

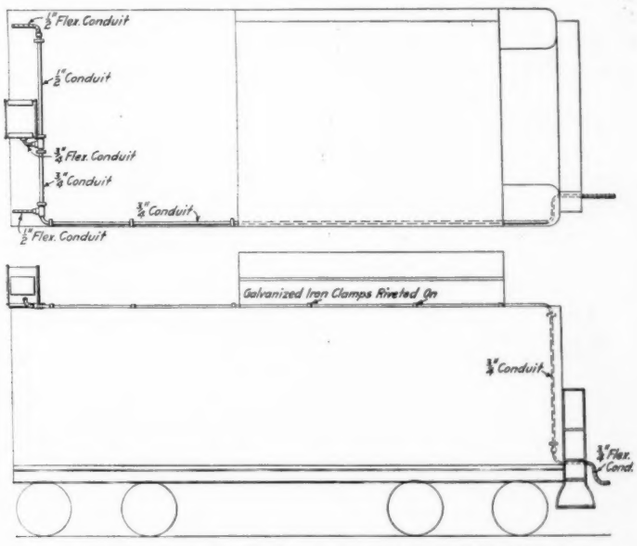


Fig. 5—Arrangement of Wiring on Locomotive Tender

The entire wiring is well protected from abrasion and chances of short-circuiting by a double sheathed conduit where it is exposed. The leads from the generator pass

through a fuse box into a cast iron condulet, from which they pass back to a distribution box on the outside of the cab and forward through the handrail to the front of the locomotive. It is to be noted that condulets are provided at both ends of the handrail in order that the connections may be easily broken when stripping the locomotive. In fact, this principle has been followed throughout the entire system. It is also to be noted that the handrail columns have been modified. The

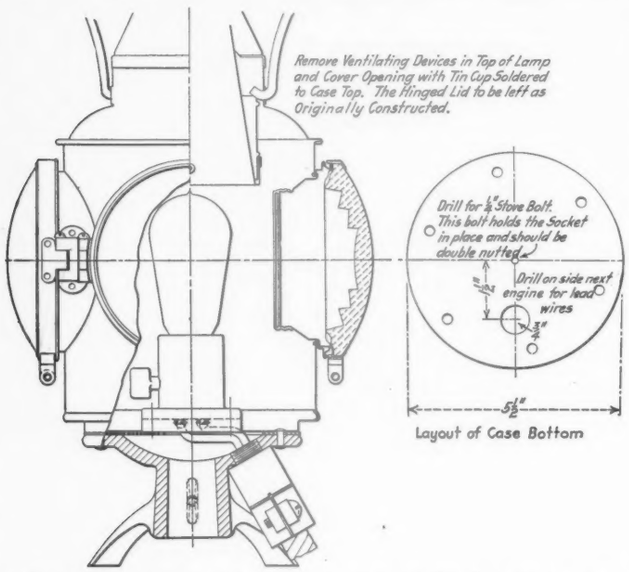

Remove Ventilating Devices in Top of Lamp and Cover Opening with Tin Cup Soldered to Case Top. The Hinged Lid to be left as Originally Constructed.
Drill for ¼" Stove Bolt. This bolt holds the Socket in place and should be double nutted
Drill on side next engine for lead wires
5½"
Layout of Case Bottom

Fig. 6—Arrangement of Classification Lamp for Electric Lighting

column is split, as indicated in Fig. 3, to permit the easy removal of the handrail with the wires intact. At the front of the locomotive the wiring passes from the condulet to the right-hand classification lamp and also over the top of the boiler through the handrail to the classification lamp on the other side and to the headlight and number plate, one-half inch flexible conduit connecting the headlight with the condulet. The locomotive distribution box is of a design particularly adapted to the service and is made by the Central Electric Company. This box is at-

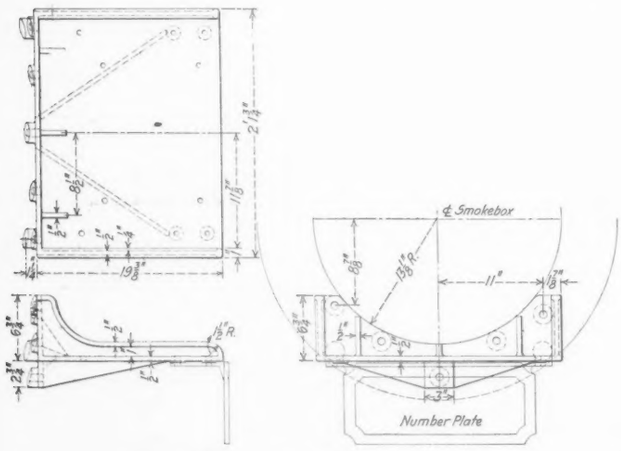


Fig. 7—Bracket for Locomotive Headlight

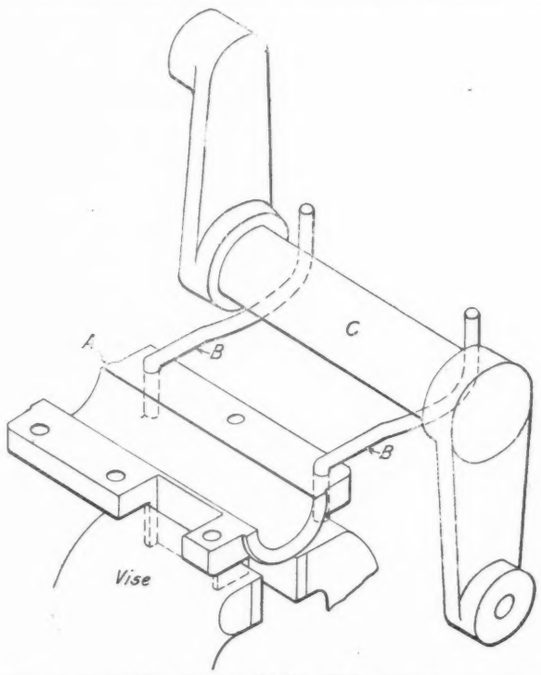
tached to the front of the cab, the wires from inside and outside the cab terminating there, there being suitable connections for the wires. When it is desired to remove the cab from the locomotive the wiring both in the cab and on the locomotive can be left intact, the only operation necessary being that of disconnecting the locomotive wires from the distribution box. The cab wiring is run through flexible conduit attached to the roof of the cab. The cab lamp, which is shown in Fig. 4, is made of cast iron and it is held on a cast iron arm which is fastened to the backhead of the boiler and so located as to permit the rays of light from the lamp casing striking the water glass and gages. Only one lamp is used to illuminate the backhead of the boiler. The deck light has a spring grip socket and is located on the roof of the cab. The reading light, as stated before, is located at the side of the cab directly behind the engineer. On locomotives for shuttle and yard service the wiring passes through a ¾-in. flexible conduit down to the bottom of the cab where another distribution box similar to that at the front of the cab is located. The wires between the locomotive and tender pass through a ¾-in. flexible conduit up the side of the tender on the inside, and back to the light at the rear of the tender, as indicated in Fig. 5.

It was found necessary to make some changes in the construction of the classification lamp, which are indicated in Fig. 6. The bracket for the headlight and number plate is shown in Fig. 7.

FITTING ROCKER SHAFT BOXES

BY A. G. JOHNSON
Chief Draftsman, Duluth & Iron Range, Two Harbors, Minn.

As a means to facilitate the fitting of rocker shafts in their boxes the arrangement shown in the illustration has been devised and found successful. The rocker box is held in the vise as shown, it being ready for scraping or spotting. If, as



Method of Holding Rocker Shafts While Fitting the Boxes

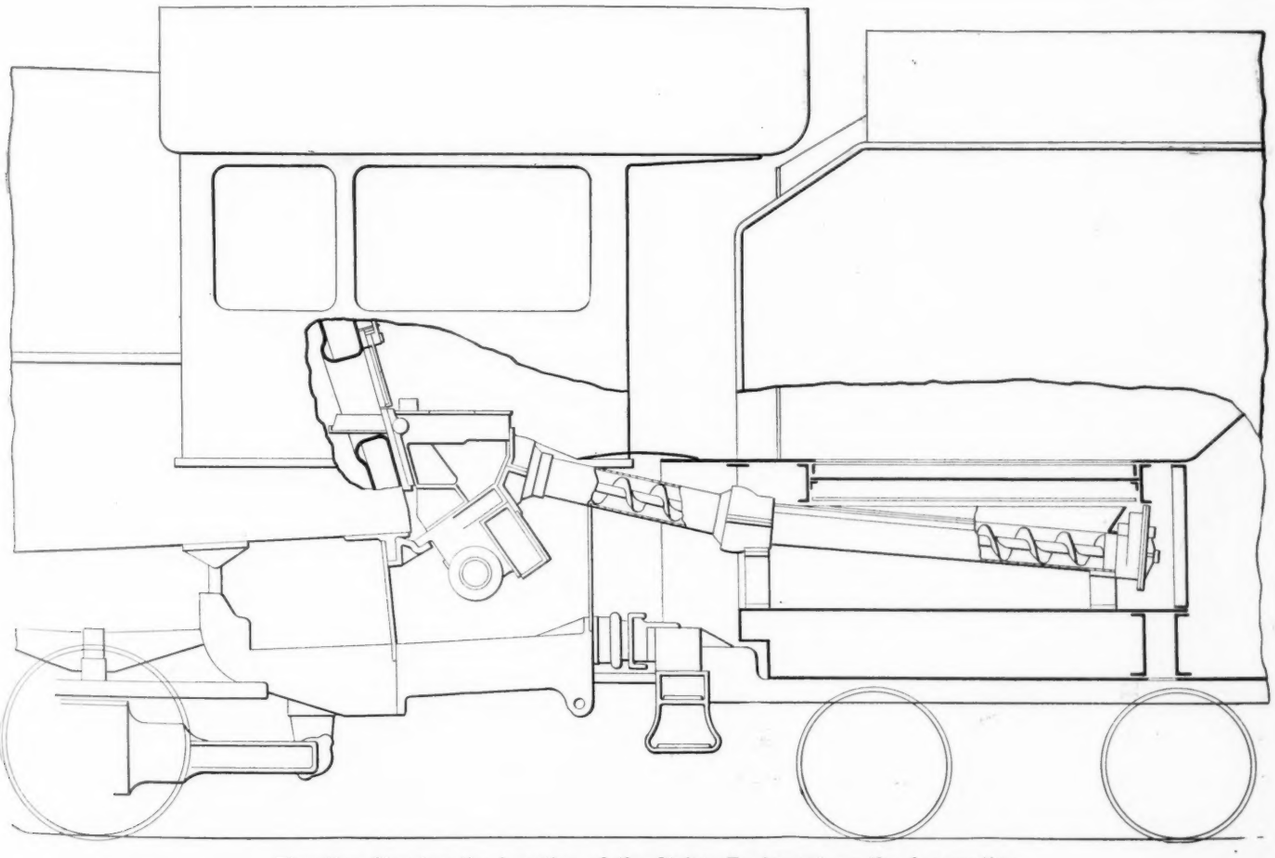
it is often necessary, the rocker arm *C* has to be lifted to and from the bench every time it is desired to spot the box two men will be required to handle it. In addition to this it is heavy work and takes time. By providing two ¾-in. rods, as shown at *B*, bent to fit into the bolt holes of the box, the rocker shaft can be lifted out and rolled back out of the workman's way and at the same time be easily handled. With it in this position the box can be spotted and the shaft tried as many times as necessary without much time or physical strength and without the danger of denting or marring the bearing or the box.

THE ELVIN MECHANICAL STOKER

A mechanical stoker, in which the entire distribution of the coal in the locomotive firebox is effected by mechanically operated shovels, without the use of steam jets, has been developed by the Elvin Mechanical Stoker Company, New York. One of these stokers has been in road service on the Erie for the past three months with results which have demonstrated the feasibility of the method of distribution employed and which indicate an economy in the use of coal equal to, if not exceeding that obtainable by hand firing under favorable conditions. The locomotive equipment consists essentially of three parts: the stoker proper, the agitator and feed control on the tender and the screw conveyor between the engine and tender. The equipment is designed to handle the usual grade of prepared stoker coal.

The stoker proper is assembled in a complete unit which is mounted on the back boiler head and braced to the mud ring by cast brackets. The proportions of the machine and its location on the backhead are shown in one of the drawings. The one design is adapted to backheads of varying slopes by the insertion of filler blocks of suitable taper between the stoker and the boiler head. The stoker consists essentially of two distributing shovels operating through the fire door opening and an elevator for bringing the coal from the conveyor to the level of the shovels.

The distributing shovels are mounted on vertical shafts, the lower ends of which carry segmental bevel gears. These gears are driven by bevel segments carried on the upper ends of a pair of centrally pivoted drive arms, the lower ends of which carry steel rollers running in the grooves of a double-faced flat cam. The cam is driven by a worm gear from the main stoker shaft and revolves in a plane approximately parallel to the usual inclination of the backhead of the boiler. Each revolution of the cam completes a cycle of shovel operation; that is, one shovel moves around into

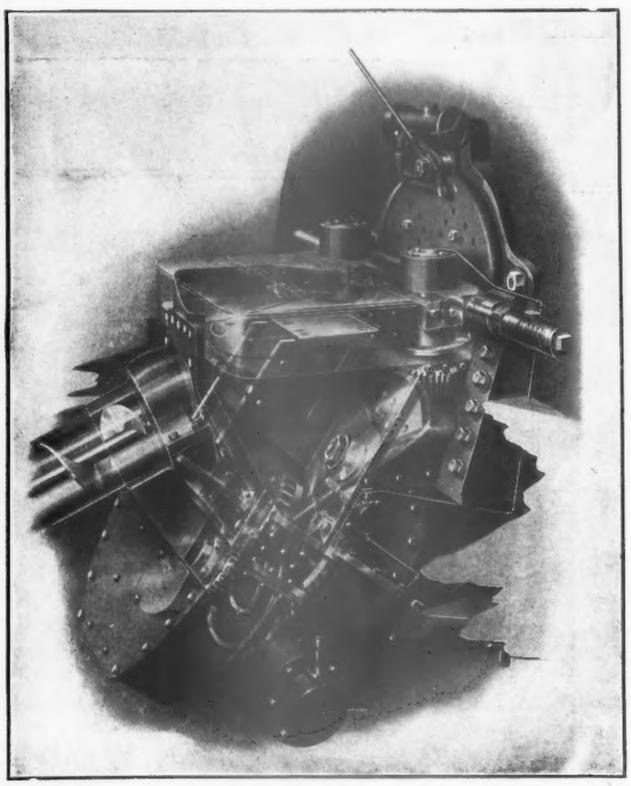


Elevation Showing the Location of the Stoker Equipment on the Locomotive

the firebox and returns to remain idle while the other shovel performs the same movement.

Upon the cam is mounted a spur gear which, through a meshing gear of one-half its diameter, drives the elevator crank shaft. The elevator is thus raised and lowered twice during each revolution of the cam, one for each of the two shovels. The elevator, which moves up and down on an inclination parallel to the cam, has an approximately level top surface measuring 7 in. by 12 in. In its lowest position coal as it is delivered by the screw conveyor falls directly on the top of the elevator. As it moves up, a long apron extending downward from its back side forms the front wall of a V-shaped pocket in which the coal accumulates until the elevator again returns to the lower end of its stroke. As the elevator is gear driven directly from the cam, its movement synchronizes perfectly with that of the shovels. The crank is set so that the elevator reaches the top of its stroke just as a shovel is swinging over it. A slight inclination of the top of the elevator compensates for the small amount of downward movement which has taken place before the shovel has moved completely across its top. One of the shovels thus picks up the pile of coal from the top of the elevator at each stroke and carries it forward into the firebox.

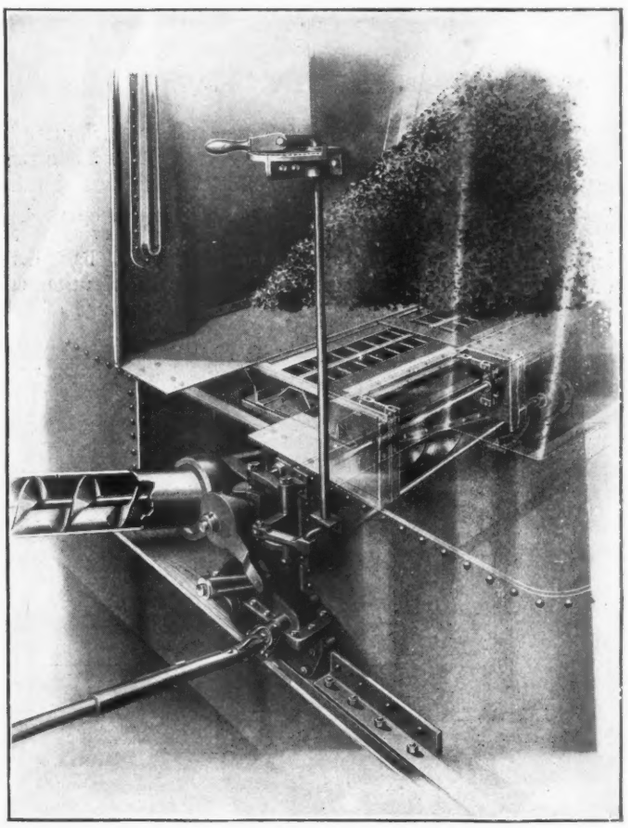
The upper part of the stoker casing forms a box-shaped chamber known as the shovel box, which is covered by



Phantom View of the Elvin Stoker Attached to the Back Boiler Head

hinged lids. The forward end of this box is open to the firebox and the shovels swing therein. The total height of the box is 5½ inches over the cover. The stoker thus uses the lower 5½ inches of the firedoor opening and that part of the door opening above the stoker is closed by a butterfly door, which is used for inspection and hand firing if necessary.

The shovels are L-shaped, with a flat bottom and a back, the maximum height of which is 4½ in. This is reduced to a height of 1¼ in. around the end of the shovel to permit a portion of the coal to be retained in the shovel until the end of the forward throw. As will be seen from one of the drawings the shovels are pivoted at either side of the fire door, and are swung through an arc of about 140 deg. The use of a cam drive has made possible the attainment of the speed variations required in the course of the forward swing of the shovel to accomplish the picking up and distribution of the fuel without shock and with constant uniformity. In action the shovel movement is uniformly accelerating until the charge of fuel has been picked up, or until the shovel has passed over the elevator; then the movement is rapidly accelerated until the shovel tip has entered the firebox when



Phantom View of the Tender Equipment of the Elvin Stoker

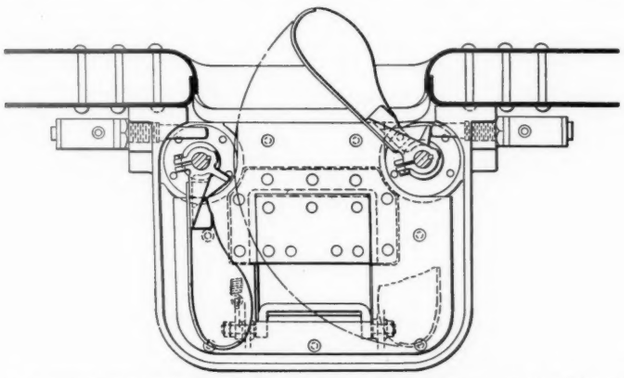
it is rapidly decelerated. During this deceleration the fuel slides forward on the shovel and off the end where the back is reduced in height and at a tangent to the back of the shovel; but as the back is moving in an arc the effect is to spray the fuel throughout the remaining travel of the shovel, and that portion of the fuel held by the 1¼-in. vane is projected parallel to the backhead when the shovel stops.

The changes in the speed of the forward movement of the shovels have the effect of distributing the fuel uniformly over the entire grate area. The distribution is capable of variation, by changes in speed of the stoker engine; an increase in speed throws a greater amount of the fuel toward the front of the firebox, while a decrease fires heavier to the rear. Irrespective of the speed of the shovels, however, a portion of the fuel is always held by the shovels to fire the back corners of the box. In practice it is found that there is a certain speed which will give the proper distribution under normal conditions and the stoker should be operated at this speed, except when occasionally it may be advisable to fire heavier at the front or rear of the firebox. In practice the speed of firing is about 34 shovels per minute, or a cam speed of 17 r. p. m. The amount of fuel fired is inde-

pendent of the shovel speed, and the distribution is not affected by the quantity.

All working parts of the stoker, with two exceptions, are run on ball bearings in a dust-proof casing, and are in a constant bath of oil. The oil level is maintained at a point above the main worm shaft and the oil is pumped to the highest bearings to return by gravity. The connecting rod driving the elevator, being outside the stoker casing proper, is provided with graphalloy bearings which require no oil and give long service without attention. The stoker is operated by a No. 3½ Dake reversing engine, which is rated at 7½ h. p. at 100 lb. pressure. The steam line to the stoker is provided with a regulating valve which is set for 25 lb. and is blocked for a maximum of 60 lb. The whole of the stoker mechanism is designed to withstand the maximum power of the engine without failure, and the engine will stall before any part of the mechanism can be unduly stressed.

The conveyor extends from the stoker rearwardly under the coal space of the tank and is in two parts. It is supported rigidly upon the tank, and the portion between the engine and the tank is arranged to swivel to compensate for curvature and to telescope for varying lengths of coupling. The rear end of the conveyor screw is carried in a trough



Top View of the Stoker with the Cover Removed from the Shovel Box, Showing the Elevator at the Top of Its Stroke

and between engine and tank it is carried in a pipe. The conveyor is driven from the rear through gearing enclosed in dust-proof casings. The drive is taken through worm gearing from the main stoker shaft, enclosed in the stoker casing and running in oil. A universal slip joint shaft transmits the power from the engine to the tender.

Under the floor of the tank and above the conveyor is the feeder which consists of an agitator, a deflector and a feeder plate. The agitator is a grating with a double row of 3⅛ in. openings, and is operated from a rock shaft which also moves the feeder plate. The feeder plate is located under the deflector plate so that when operating full stoke the openings in the plate register fully with openings on either side of the deflector plate, first on one side and then on the other.

A simple mechanism on the rock shaft, which operates the agitator and feed plate, provides for varying the throw of the shaft and the size of the plate openings which register with the deflector plate openings, thus controlling the quantity of coal fed to the conveyor, which runs at constant speed. This device is controlled by a handle operating on a quadrant on the front of the tank, where it is readily accessible to the fireman. The range of feed varies from zero to the maximum, which is 12,000 lb. of coal an hour.

The conveyor is designed to carry the maximum coal feed when running one-third full. This makes the movement of the fuel easy as the action of gravity tends to roll the coal along ahead of the screw, and it reduces the danger of clogging to a minimum. The ease with which the coal is moved may be tested by turning the engine over by hand, which can easily be done with the whole device under full load.

The stoker maintains a very thin fire over a greater part of the grate area, which gradually becomes heavier toward the front, rear and sides of the box, where the heaviest fire is needed. The thin character of the fire is clearly indicated by the fact that within a very few minutes after the throttle has been closed and the stoker stopped, the only fire still burning is around the outside of the firebox, while the central portion of the grate is dead. On starting the stoker, however, the thin charges of coal immediately ignite over the entire area of the grate and a uniformly hot fire is maintained as long as the stoker continues to operate. The rapid building up of the fire and the steam pressure following the starting of the stoker has made possible a saving in standby losses, as little need be done, either to maintain the fire or the steam pressure during detention time on the road beyond the minimum necessary to start the train. A characteristic of the distribution of the coal which also tends toward economy is the projection of the lumps forward under the arch while the finest of the coal is retained in the shovels to be deposited in the back corners of the box furthest from the most violent action of the draft. Comparative freedom from large cinders is a noticeable feature of the operation of the locomotive equipped with this stoker.

TEST DATA

The Erie locomotive to which the Elvin stoker was applied is of the Santa Fe type with the following dimensions:

Size of cylinders	31 in. by 32 in.
Diameter of drivers	63 in.
Weight on drivers	337,400 lb.
Total weight of engine loaded	417,200 lb.
Total heating surface	5,660 sq. ft.
Superheating surface	1,389 sq. ft.
Total equivalent heating surface	7,743.5 sq. ft.
Tractive effort	83,000 lb.
Grate area	88 sq. ft.

A series of tests were made with this locomotive, employing a dynamometer car and accurate means for correctly determining the quantity of coal and water used. These tests were made on the Second district of the Meadville division between Meadville, Pa., and Kent, Ohio, during the month of November last, under prevailing temperatures of 32 deg. F. This division has a ruling grade both east and westbound of one per cent and is generally rolling in character with little to distinguish between the physical characteristics of the division east and westbound. A brief summary of the results of these tests is given in the table.

AVERAGE RESULTS OF ELVIN STOKER TESTS ON THE MEADVILLE DIVISION OF THE ERIE RAILROAD

Length of run, miles	89.3
Time on road, hr. min.	9:50
Detentions, hr. min.	3:57
Running time, decimal hr.	5.88
Actual M's (1,000 lb.)	4,243
Adjusted M's	5,133
Total actual M's (inc. eng. and ten.)	4,816
Average drawbar pull, lb.	24,362
Average speed, m.p.h.	15.56
Average temp. superheated steam, deg. F.	693
Million ft-lb. of work	11,482
Total coal as fired, running time, lb.	25,679
Coal as fired to do 11,482 million ft.-lb. work, lb.	25,679
Equivalent evap. per lb. dry coal, running time, lb.	8.60
Equivalent evap. per lb. dry coal, combustible, lb.	9.59
B. t. u. per lb. of coal as fired	13,157

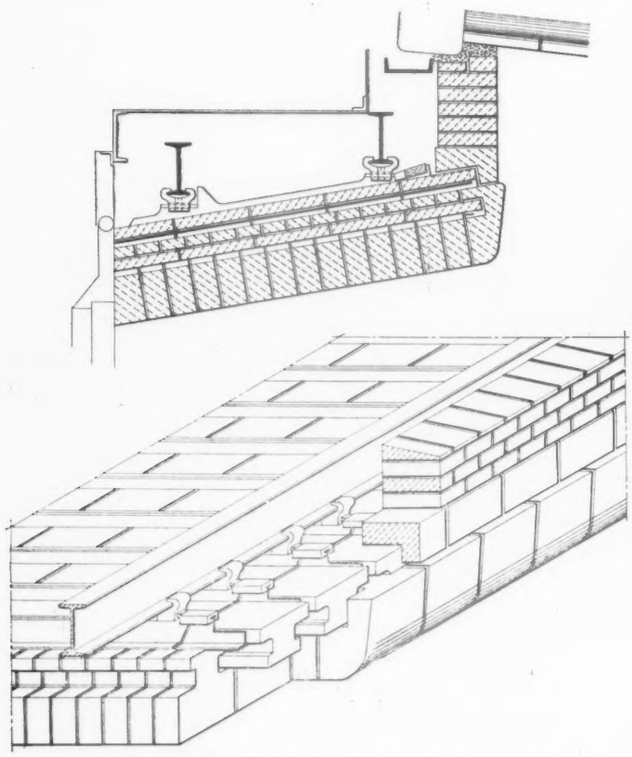
It was developed during the tests that practically perfect distribution of the fuel was obtained under all conditions. The fire was maintained at a uniform level without the necessity of using the rake or shaking the grates, notwithstanding the variable operating conditions met on this division. The engine arrived at terminals with approximately six to ten inches of fire on the grates, except a point immediately under the arch at the forward end of the firebox, where the fire was somewhat heavier.

No difficulties were encountered in cleaning the fire at ter-

minals because of the comparative absence of clinker. The results of the tests indicate very favorable evaporation per pound of coal fired. Under ordinary circumstances locomotives of the Santa Fe type on this division require coaling and fire cleaning between terminals. During the tests, however, it was unnecessary on any of the trial trips to clean the fire on the road and the grates were operated only to relieve the accumulation of ashes. On two occasions it would have been easily possible to make a round trip without attention to the fire other than shaking the grates. This condition is in a measure attributed to the absence of moisture which is injected into the firebox with most of the other types of locomotive stokers now in use. The locomotive will handle tonnage trains over this division with the use of less than one tank of coal.

DOUBLE SUSPENSION ARCH FOR STATIONARY BOILERS

It is usually desirable to operate stationary boilers for long periods without shutting them down. When working at high capacity it is not an infrequent occurrence to have the arch give way, and this often happens when it is extremely inconvenient to take the boiler out of service. There has recently been devised by the Liptak Fire Brick Arch Company, St. Paul, Minn., a type of arch for stationary boilers which is intended to overcome such difficulties. This is known as the Liptak Double Suspension Arch. It is made up of two layers of interlocking bricks, suspended from cast iron supporting beams which in turn are fastened by clips to transverse I-beams. The perspective drawing accompanying this article shows the construction clearly. It will be noted that the upper arch furnishes almost complete protection for the cast iron supporting beams. Even if the lower arch is completely burned away the boiler can still be operated until the time when it can be shut down without inconvenience.

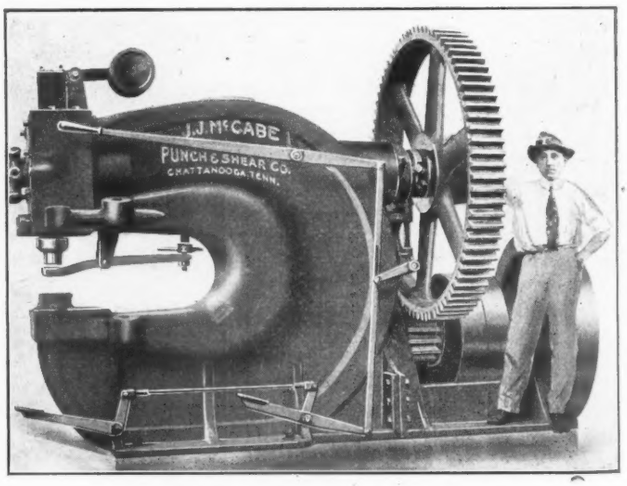


Double Suspension Arch for Stationary Boilers

The lower arch can readily be renewed by the boiler room force as it is simply necessary to slide new lower arch bricks into the grooves of the reserve arch. This eliminates the services of an experienced mason, which are not always available. In case the end blocks are completely burned away, exposing the ends of the cast iron supporting beams to such an extent as to damage them, it is not necessary to renew the entire beam as replaceable tips are provided. The rear bricks in any arch are the first to give out. With this type it requires only a short time after the boiler is cooled down to renew the rear blocks and place the boiler in condition for service. It should be noted that the L-shaped blocks resting on the reserve arch and supporting the brickwork from the arch to the boiler header do not interfere with the lower arch. This permits the renewal of the lower brick without disturbing the rear wall. One of the important advantages of this type of arch lies in its adaptability. It can be built for any width and length to suit the requirements of all types of boilers and stokers. It is claimed that the Liptak arch has a long life and will stand high overload. Arches of this type have been in service for several months and the only repairs required have been the application of new rear blocks.

HEAVY PUNCH AND SHEAR

An improved design of heavy pattern punch and shear machine has been recently developed by the J. J. McCabe Punch & Shear Company, New York City. The illustration shows a machine having a 36-in. throat. The 50-in. machine is of the same general type. Particular attention has been given in the construction of the machine to rigidity to withstand heavy service, the frame having a heavy rib on the back. The head is driven by cam and rollers of carbon steel, which doubles the power during the working stroke and eliminates friction and wear. The clutch is of a new style, being made entirely of steel and equipped with an automatic stop so that the machine may be stopped at any desired point of the stroke. It is operated by either a hand lever or two foot levers arranged conveniently to the operator. The bearings of the machine are of hammered steel forged from the billet, the main bearings having heavy bronze bushings with facilities for taking up the wear. This machine will punch a two-inch hole through one-inch plate and will shear 1½-in. plate, 8-in. by 1⅛ flat bars, 2¼-in. round bars, or 6-in., by 6-in. by ¾-in. angles. The regular equipment provided consists of tight and loose pulleys for belt drive, a punch and die holder, and one punch and die of any size desired up to the full capacity of the machine.



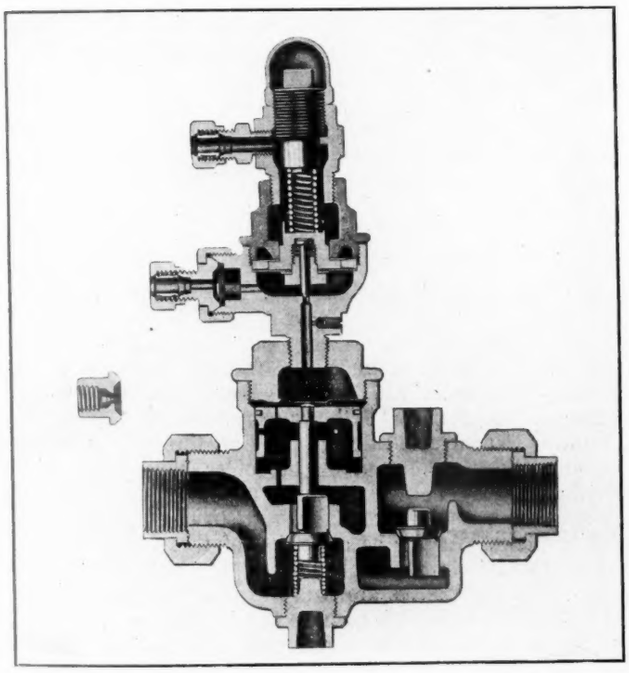
Heavy Duty Punch and Shear

PARASITE RESERVOIR GOVERNOR

The use of compressed air on locomotives for pneumatic devices other than the air brake, such as reversing gear, bell ringers, water scoops, etc., has reached a stage where it is considered necessary by some roads to protect the supply of air for the air brake from becoming depleted from the operation of these so-called "parasites." To accomplish this protection the Westinghouse Air Brake Company has developed a device known as the "Parasite" reservoir governor, which is so designed as to permit charging of the "Parasite" reservoir (or reservoir from which the parasites are supplied) from the main reservoir, only when the main reservoir pressure is above a certain predetermined amount sufficient to safely operate the brakes. The air-operated devices on the locomotive are thereby prevented from "robbing" main reservoir pressure, and, in consequence, the brake system itself.

This governor consists of a diaphragm portion and a body or valve portion which embodies a piston, a spring valve and a non-return check valve. Pipe connections are made, as illustrated, from the main reservoir and the brake valve feed pipe to the diaphragm portion and from the main reservoir to the body portion, and also from the parasite reservoir to the body portion.

When charging the parasite reservoir, air will flow from the main reservoir to below the diaphragm and through the



Governor for Regulating the Pressure of the "Parasite" Reservoir

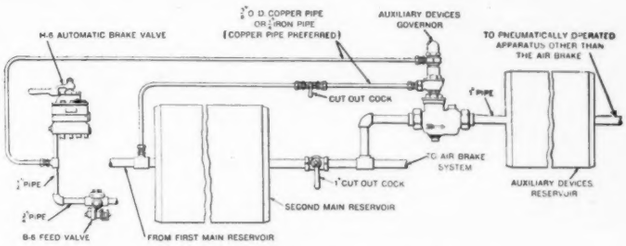
feed valve to the top of the diaphragm, but the diaphragm valve will remain seated until the main reservoir pressure reaches that for which the regulating spring is adjusted, plus the pressure on the brake valve side of the feed valve, when the valve will unseat, allowing air to flow to the top of the piston in the body.

The piston is thereby moved downward, opening the valve below it, at the left, and allowing main reservoir air to flow directly to the parasite reservoir past the non-return check at the right.

When air is being taken from the parasite reservoir for the operation of the parasites the pressure will fall a like amount in both reservoirs until it reaches that for which the governor head is set, when the diaphragm valve will seat and prevent further flow of air from the main reservoir.

Should the pipe between this governor and the parasite reservoir break, air in the main reservoir will not be lost because the diaphragm valve will seat as soon as the pressure in the parasite reservoir drops to that for which the governor head is set. Should a main reservoir pipe break, the non-return check valve 5 (at the right) will prevent the loss of parasite reservoir air.

Thus, should the parasite reservoir pipe break or the pressure become reduced abnormally through operation of the

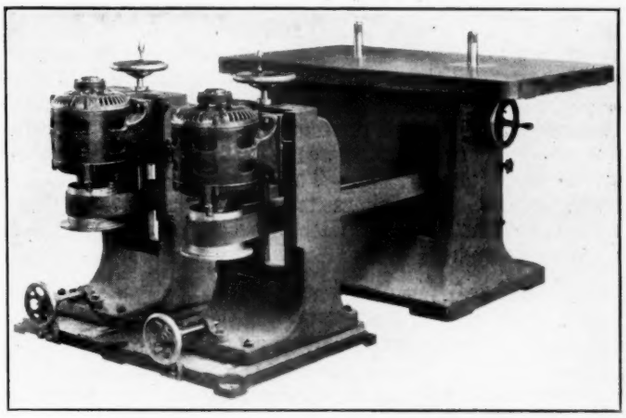


Connections for the "Parasite" Governor

parasites, the parasite reservoir governor would prevent the loss of main reservoir air below a point necessary for the operation of the brakes. Furthermore, should main reservoir pressure be lost through the breakage of a main reservoir pipe or be reduced abnormally from any other cause, the Parasite reservoir governor would prevent the loss of parasite reservoir pressure, thereby making it possible to reverse the engine if provided with a pneumatic reversing gear, or to operate the other parasite apparatus.

NEW MOTOR DRIVE FOR DOUBLE SPINDLE SHAPERS

The Oliver Machinery Company, Grand Rapids, Mich., has developed an interesting and useful compact motor drive for double spindle shapers. As shown by the illustration, standard vertical motors are used, one for each spindle. Each motor is mounted on vertical gibbed ways and is adjusted in height by means of a handwheel and screw to accommodate any height of the spindle which may be required



New Motor Drive for Double Spindle Motors

by the work at hand. Each motor stand can be adjusted longitudinally and the motors are controlled independent of each other, thus permitting the use of but one spindle when two are not necessary. This new arrangement takes up a small amount of floor room, occupying space seven feet long by five feet wide. Standard vertical motors of any type can be used, there being no need for a special built-in motor. The arrangement can be applied to old shapers as well as new and any kind of starting units can be furnished.

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WE GUARANTEE, that of this issue, 7,700 copies were printed; that of these 7,700 copies 6,872 were mailed to regular paid subscribers, 57 were provided for counter and news company sales, 192 were mailed to advertisers, 25 were mailed to employees and correspondents, and 554 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 15,100, an average of 7,550 copies a month.

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The Canadian Railway War Board announces that freight cars of Canadian roads may now be allowed to go into the United States. During the pressure of the past year this use of Canadian cars has been forbidden. Arrangements have now been made with the United States Railroad Administration whereby Canadian cars will be promptly returned to their owners.

S. M. Felton, president of the Chicago Great Western, and until December 31 director general of military railways, was awarded the distinguished service medal by the Secretary of War on January 18, on the recommendations of Gen. Peyton C. March, chief of staff, for "especially meritorious and conspicuous service in supervising the supply of railway material and the organization of railway operation and construction troops."

In the week ending January 4, locomotives in service on lines in the Northwestern region numbered 8,004, making the efficiency 85.2 per cent. The number of freight cars on the Northwestern lines during the week totaled 370,052, compared with an ownership of 334,615. Bad order cars numbered 20,886 (or 5.6 per cent), as compared with 18,916 (6.5 per cent) for the same week in 1918. Freight cars in outside shops totaled 208. The number of employees in service in car repair shops totaled 21,275 (working an average of 47 hours in the week), as compared with 17,537 in the same week of 1918.

Upon the recommendation of General Pershing, a distinguished service medal has been awarded to Brig. Gen. William W. Atterbury, formerly vice-president of the Pennsylvania Railroad, "for exceptionally meritorious and distinguished services." As director general of transportation in the face of almost insurmountable obstacles he organized and brought to a high state of efficiency the transportation service of American Expeditionary Forces. The successful operation of this most important service, upon which the movements and supply of the combat forces were dependent, was largely due to his energy, foresight, and ability.

The National Railways of Mexico, according to a report from Monterey, are being rehabilitated under plans which are making a fair degree of progress. All bridges on the main lines are now repaired and in use, and many of the stations have been rebuilt in a permanent manner. The roadbed is reported in fair condition. The number of locomotives in service is about 500, of which 100 belong to industries along the line and are used in the freight service of their owners. About 250 more locomotives are awaiting repairs, delay having been incurred in getting the repair parts from the United States. To handle even the minimum volume of traffic about 1,000 locomotives ought to be constantly in use, and the question of acquiring some new ones is now under consideration.

The Present Position of German Rolling Stock

In almost every direction, says an article in a recent issue of Engineering (London), Germany finds herself in a most serious plight, and the shortage and disrepair of rolling-stock is not the least important factor. Before the war Germany had about 700,000 freight cars and 30,000 locomotives. The number of the latter, as of the former, has certainly been increased during the war, through seizures in Belgium and France; but on the other hand some 4,000 locomotives may be looked upon as at least temporarily unavailable, being at present stranded in often remote occupied territory. As far as a portion of these 4,000 engines is concerned, it is doubtful whether they will ever return. Some 8,000 locomotives are badly in need of repair. Thus the 5,000 locomotives which have to be handed over, according to the terms of the armistice, represent about one-fourth of those available, and efficient. Apart from this there is some doubt as to whether or not the locomotives of the Alsace-Lorraine State railways are included in the above 5,000 engines. The proportion of increase and decrease as regards freight cars may be taken to be about the same as with the locomotives. The question then remains as to what extent German works will be able to make good the compulsory surrender of these 5,000 engines, for of the purchase of locomotives from abroad there can be no question at present. The capacity of the German locomotive factories is at the present moment, with some reserve, put at 2,500 large locomotives per annum. This estimate, of course, is subject to sufficient raw materials and other necessities being available as well as a sufficiency of skilled and trained and willing labor. If it really were possible satisfactorily to overcome these and other difficulties, and also in other ways to return to an ordered state of affairs, and entirely to ensure and rely upon the large left-Rhine production of raw materials for the whole reconstruction period, it would take the

German railways two or three years to recover from the blow which their defeat has entailed. During this considerable period German industry would be entirely debarred from export of full-size locomotives and confined to narrow-gage engines, of which it can supply some 1,500 in the year. The position is made additionally difficult, because Germany has to deliver up efficient locomotives, so that those which remain include all those more or less unfit for use. The repair of these, in addition to that of the 8,000 locomotives referred to above, will be very difficult to effect, but as the state railways are compelled to exercise the greatest economy these repairs will probably first be proceeded with.

It is being suggested in Germany that firms which have not formerly gone in for the building of locomotives, of which the majority have been engaged in war work, might with advantage take up the manufacture of locomotives, as has already been done by the Allgemeine Elektricitäts Gesellschaft.

As regards the building of freight cars the capacity of the German works during the last few months of the war has been put at 50,000 per annum. In case all necessary raw materials which are nearly all produced within the country, be made available and the industry not be handicapped by other adverse circumstances, the above-mentioned capacity might perhaps be increased by 50 per cent. Even then it will take Germany three years to replenish her stock of freight cars.

Changes in M. C. B. Interchange and Loading Rules

The Master Car Builders' Association has recently issued Circular No. 25 announcing certain changes in the 1918 Code of Interchange Rules. A second paragraph has been added to rule 8, which specifies that when repairs are made to cars of private ownership equipped with a receptacle for cards, a copy of the billing repair card shall be inserted in the receptacle. A new rule, No. 23, has been formulated, which provides for the periodical repacking of journal boxes. Rule 120, with some modifications, has been reinstated, effective January 1, 1919, to provide for the disposition of cars belonging to private car lines and railroads not under federal control which require extensive repairs for which the owners are responsible. The circular also contains two interpretations of Article II of the rules of interchange for 1918.

The loading rules of the Master Car Builders' Association as revised for 1918 have been approved by the Railroad Administration and are now ready for distribution. Numerous changes have been made in the present volume. The size of the pages has been increased to 5¼ in. by 7½ in. in order to permit the use of larger and clearer cuts. The general rules for loading material have been grouped in the first section and following these are the complete instructions regarding the handling of various commodities. All the rules governing the loading of each commodity are grouped together so that it is not necessary to refer to various portions of the book. In case railroads desire to provide copies of the rules for shippers, any of the sections will be printed in pamphlet form by the association. The Car Service Section has issued a circular instructing the railroads to refer any questions regarding loading that may arise to the secretary of the M. C. B. Association.

MEETINGS AND CONVENTIONS

Master Boilermakers' Association.—The 1919 convention of the Master Boilermakers' Association will be held in Chicago May 26, 27, 28 and 29 at the Hotel Sherman. This will be the first convention since 1916, the association having suspended activities on account of the war. The subjects to be discussed at the convention, together with the committees, follow:

1. Proper method of threading radial stays and tapping the hole in the boiler for them.
   Is it necessary to give radial stays the same lead as the tap with which the holes were tapped?
   Committee: H. J. Raps, chairman; Andrew Hedberg, J. J. Keogh, J. B. Smith, T. J. Reddy.
2. Which is the better time for drilling tell-tale holes, before or after application of the bolts?
   Which is the better method for drilling in either case?
   What is the best style of drill for opening up tell-tale holes in old staybolts?
   Does it pay to use a high speed drill for this purpose?
   What is the best lubricant for the drill?
   Committee: L. R. Porter, chairman; A. N. Lucas, S. M. Carroll, Bernard Wulle, C. E. Erwin.
3. Effect of proper upkeep of ash pan and front end draft appliances on fuel economy.
   Method used in determining proper design for various classes of locomotives.
   Committee: George Austin, chairman; E. J. Nicholson, Fred Bayer, H. F. Weldin, George Hewitt.
4. What is the best method for scaling superheater flues in the boiler?
   What is the best method of rattling flues?
   What is the best method of handling flues in and out of the rattler?
   How many revolutions per minute should the rattler make for 2-in. and for 5¾-in. flues?
   Describe method for safe ending superheater flues.
   Committee: Frank Gray, chairman; W. J. Murphy, Andrew S. Green, John Harthill, J. J. Mansfield.
5. What is the best style grate for bituminous coal?
   Where should the dump grate be located, (a) in road engines, (b) in switch engines?
   What should be the percentage of opening in grates?
   What should be the percentage of draft opening in ash pans compared with area of grates?
   Committee: W. H. Laughridge, chairman; L. M. Stewart, T. P. Madden, C. P. Patrick, C. A. Nicholson.
6. What should be the minimum distance between the grates and the lower part of arch tubes for different classes of locomotives?
   What is the proper distance from the door sheet to the brick arch and from the crown sheet to the brick arch for the various classes of locomotives?
   Committee: C. L. Hempel, chairman; W. F. Fantom, A. E. Brown, E. W. Young, G. B. Usherwood.
7. What is the best method of bracing locomotive tenders? Describe method used.
   Committee: Thomas Lewis, chairman; E. J. Sweeney, J. J. Orr, J. P. Malley, J. T. Johnson.
8. Oxy-acetylene and electric welding.
   Committee: H. J. Wandberg, chairman; B. F. Sarver, L. M. Stewart, T. F. Powers, J. J. Davey.
9. What is the advantage of cutting off stay ends with oxy-acetylene over old method of nippers and chisels?
   Committee: W. S. Larason, chairman; John McGarrigal, J. B. Tynan, E. H. Hohenstein, A. E. Shaule.
10. General discussion.

Central Railway Club.—At the January 10 meeting of the Central Railway Club the following officers were elected for the ensuing year: President, Frank C. Pickard, master

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Feb. 3	Storage of Coal and Spontaneous Combustion	D. H. Pudney	James Powell	P. O. Box 7, St. Lambert, Que.
Central	Mar. 14	Unified Inspection and Maintenance of Car Equipment	J. J. Tatum	Harry D. Vought.	95 Liberty St., New York.
Cincinnati	Feb. 11	Efficiency	Charles Dick	H. Boutet	101 Carew Building, Cincinnati, Ohio.
New England	Feb. 11	United States Railway Batteries in France. Red Cross Work in France		W. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Feb. 21	Standardized Statistics	Wm. J. Cunningham.	Harry D. Vought.	95 Liberty St., New York.
Pittsburgh	Feb. 28			J. D. Conway	515 Grandview Ave., Pittsburgh, Pa.
St. Louis	Feb. 14	Informal talks by Lieutenant Colonel Frank G. Jonah and J. A. Somerville		B. W. Frauenthal.	Union Station, St. Louis, Mo.
Western	Feb. 17			A. F. Stuebing	750 Transportation Bldg., Chicago.

mechanic, D., L. & W.; vice-presidents, H. T. Malcolmson, superintendent, T. H. & B.; L. C. Fitzgerald, shop superintendent, Erie, and M. W. Hassett, master mechanic, New York Central. H. E. Myers, master mechanic, Lehigh Valley, was elected to the executive committee. The retiring president, W. H. Sitterly, general car inspector, Pennsylvania, was added to the list of past presidents, who are also members of the executive committee.

Master Mechanics' Association.—At a meeting of the executive committee of the American Railway Master Mechanics' Association, held in Chicago on January 3, W. J. Tollerton, general mechanical superintendent of the Rock Island Lines, was appointed president of the association to fill the vacancy caused by the resignation of F. H. Clark. C. F. Giles, superintendent of machinery of the Louisville & Nashville, was appointed first vice-president, and C. H. Hogan, assistant superintendent motive power, New York Central, was appointed second vice-president. The position of third vice-president was left vacant and will be filled by election at the time of the next annual meeting of the association.

The June Mechanical Convention.—J. D. Conway, secretary of the Railway Supply Manufacturers' Association on January 23, sent out circular No. 1 extending an invitation to manufacturers of and dealers in railway supplies to exhibit at Atlantic City in June, and giving full details as to the exhibit arrangements.

In his circular Mr. Conway says:

"This is the first exhibition that has been held for three years. The railroad associations have expressed their earnest desire that our association should make a full exhibit, and the United States Railroad Administration gives its unqualified approval of it. Invitations are being extended in the name of the three associations to all foreign trade bodies in this country, and, through the embassies at Washington, to all foreign governments (except the Central Powers), inviting them to send delegates or representatives to attend the conventions and examine the exhibits. The opportunity presented by an exhibition at this time for both the domestic and foreign demand is exceptional."

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Convention, May 6-8, 1919, Chicago.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

American Railway Master Mechanics' Association.—V. R. Hawthorne, 746 Transportation Bldg., Chicago. Convention, June 23-25, 1919, Atlantic City, N. J.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 841 Lawlor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. R. McMunn, New York Central, New York, N. Y.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio.

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 26-29, Hotel Sherman, Chicago.

Master Car Builders' Association.—V. R. Hawthorne, 746 Transportation Bldg., Chicago. Convention, June 18-21, Atlantic City, N. J.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Railway Storekeepers' Association.—J. P. Murphy, Box C. Collinwood, Ohio.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

Personal Mention

GENERAL

N. Bell, formerly master mechanic of the Minnesota and Iowa divisions of the Illinois Central with headquarters at Waterloo, Iowa, who has just returned from military service, has been appointed to the same position, succeeding O. A. Garber.

C. H. Dyson has been appointed fuel agent of the Baltimore & Ohio—Western Lines, the Dayton & Union Railroad, and the Dayton Union Railway, with headquarters at Cincinnati, Ohio.

A. L. Greburn, assistant superintendent of rolling stock of the Canadian Northern, with office at Toronto, Ont., has been appointed general fuel agent of the Canadian National Railways, with office at Toronto.

W. F. Kaderly, general superintendent of the Georgia Southern & Florida, the Hawkinsville & Florida Southern and the St. Johns River Terminal, has been appointed superintendent of motive power of the Southern Railroad, Lines East, with headquarters at Charlotte, N. C., succeeding E. C. Sasser, resigned.

William Gemlo, master mechanic of the Minneapolis & St. Louis at Marshalltown, Iowa, has been promoted to superintendent of motive power and rolling stock, with headquarters at Minneapolis, Minn., to succeed G. M. Seidel. Mr. Gemlo was born at Glasgow, Canada, on September 28, 1868. He began railway work with the Minneapolis & St. Louis as a locomotive fireman in September, 1888, and served in that capacity until October, 1896, when he was promoted to locomotive engineer. In June, 1907, he was appointed roundhouse foreman, and two years later traveling engineer. In October, 1913, he was promoted to master mechanic at Marshalltown, Iowa, which position he held until his recent appointment as superintendent of motive power and rolling stock.

W. Gemlo

E. E. Ramey has been appointed superintendent of fuel and locomotive performance of the Baltimore & Ohio, Eastern Lines; the Coal & Coke; the Wheeling Terminal Railroad; the Western Maryland; the Cumberland Valley, and the Cumberland & Pennsylvania Railroad. The position of supervisor of fuel consumption has been abolished. A photograph, and a sketch of Mr. Ramey's career were published in the *Railway Mechanical Engineer* for May, 1918, on page 294.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

O. A. Garber, master mechanic of the Illinois Central at Waterloo, Iowa, has been transferred to Memphis, Tenn., succeeding W. H. Watkins, granted a leave of absence.

W. B. KILGORE, road foreman of engines of the Baltimore & Ohio, Western Lines; the Dayton & Union Railroad, and the Dayton Union Railroad, with office at Dayton, Ohio, will also assume the duties of trainmaster of the Wellston sub-division, succeeding W. E. Duffey, who has been transferred.

P. T. O'NEILL has been appointed division master mechanic of the Chicago, Milwaukee & St. Paul with headquarters at Spokane, Wash., succeeding Fred Lowert, who has been transferred to the St. Paul shops at Tacoma, Wash. Mr. O'Neill was formerly superintendent of motive power of the Idaho & Washington Northern at Spirit Lake, Idaho, and after that line was purchased by the St. Paul he was appointed general foreman at the Spirit Lake shops and later transferred as general foreman to the Tacoma, Wash., shops.

CAR DEPARTMENT

GEORGE W. DITMORE, assistant master car builder of the Delaware & Hudson, has been appointed master car builder of that road, the Greenwich & Johnsonville, the Wilkesbarre Connecting Railroad, and the Schoharie Valley Railroad, with headquarters at Colonie, N. Y. The position of assistant master car builder has been abolished. Mr. Ditmore was born on February 17, 1878, at Jermyn, Pa., and was educated in the high school of his native town. He began railway work on June 1, 1897, as a journal packer at Carbondale, Pa., on the Delaware & Hudson, and later served as car repairer. One year later he was promoted to car inspector and served in various other capacities in the car department. In March, 1902, he was appointed an interchange car inspector at Green Ridge yard, Scranton, Pa., and then served as foreman of car inspectors and repairers at the same place and at Buttonwood, Wilkes-Barre, Pa. On December 1, 1913, he was transferred to Carbondale as shop foreman and about four years later he was promoted to division car foreman of the Pennsylvania division. Since November, 1918, he served as assistant master car builder until his recent appointment.

G. W. Ditmore

PURCHASING AND STOREKEEPING

G. W. ALEXANDER, storekeeper of the Central of Georgia, has been appointed general storekeeper with headquarters at Macon, Ga. He was born on February 21, 1886, at Senoia, Ga., and was educated in the high schools. He began railway work in 1905, as a receiving clerk in the freight agent's office of the Central of Georgia, at Atlanta. In 1907 he was appointed ticket agent at Bremen, and then to 1909 was mechanical clerk to the general foreman at Cedartown. From 1909 to 1912 he held different clerical positions in the division storekeeper's office at Macon, and later was appointed division storekeeper at Cedartown. He subsequently served as division storekeeper at Savannah, and from 1914 to April, 1918, as division storekeeper at Macon, in charge of the Macon, Southwest and Chattanooga divisions on the same road. In April, 1918, he became assistant to the Southern Regional Purchasing Committee of the United States Railroad Administration, with headquarters at Atlanta, Ga., and now returns to the Central of Georgia as general storekeeper.

J. H. NICHOLS has been appointed general storekeeper of the New York, Chicago & St. Louis with headquarters at Cleveland, Ohio.

E. A. WORKMAN, storekeeper of the Baltimore & Ohio Eastern Lines, with office at Keyser, W. Va., has been appointed storekeeper of the Maryland district, with headquarters at Camden station, Baltimore, Md., succeeding O. V. McQuilkin, deceased.

C. L. NASH has been appointed division storekeeper of the Mobile & Ohio with headquarters at Tuscaloosa, Ala., succeeding T. S. Edgell who has been transferred to other duties.

W. J. DIEHL, general storekeeper of the Mobile & Ohio, with headquarters at Mobile, Ala., now also has jurisdiction over the Gulf, Mobile & Northern.

CHARLES W. YEAMANS, assistant engineer of the Chicago & Western Indiana, has been appointed purchasing agent of that road and the Belt Railroad of Chicago, with headquarters at Chicago, succeeding R. Benson, transferred. Mr. Yeamans was born at Akron, Colo., on August 12, 1886. He began railway work on May 1, 1905, as a clerk in the engineering department of the Chicago, Burlington & Quincy, with headquarters at Chicago. Two years later he was promoted to chief clerk to the engineer of track elevation. On May 1, 1910, he resigned to go with the Chicago & Western Indiana in charge of the field construction office, with headquarters at Chicago. During the construction of Clearing yard between 1913 and 1915 he was material agent, having full charge of the ordering of materials, their inspection and distribution. Later he became chief clerk in the engineering department, and on May 1, 1918, was appointed assistant engineer in the construction department, which position he held until December 1, when he received his appointment as purchasing agent.

C. W. Yeamans

FEDERAL ADMINISTRATION APPOINTMENTS

A. F. DUFFY, assistant manager of the Safety Section, Division of Operation, of the Railroad Administration, has been appointed manager of the section, succeeding H. W. Belnap, deceased.

F. F. GAINES has been elected chairman of the Board of Wages and Working Conditions of the Railroad Administration, succeeding G. H. Sines, and A. O. Wharton has been elected vice-chairman succeeding Mr. Gaines, in accordance with the plan of rotation in office every six months, decided upon at the time of the organization of the board.

J. C. TURNER has been appointed representative of the Division of Labor. Mr. Turner will be assigned to conduct investigations and to represent the Division of Labor of the Railroad Administration in other specific matters to which he may be assigned, affecting employees of the railroads under federal control.

Supply Trade Notes

The French government has conferred upon Samuel M. Vauclain, first vice-president of the Baldwin Locomotive Works, the title of Chevalier of the Legion of Honor.

Ernest Baxter has been appointed general sales manager of the Kansas City Bolt & Nut Company, with headquarters at Kansas City, Mo., succeeding L. L. Middleton, promoted.

Edward F. Carry has resigned as chairman of the Port Facilities Commission at Washington to return to his office at Chicago as president of the Haskell & Barker Car Company.

Harry F. Worden, sales manager of the Bryant Zinc Company, with headquarters at Chicago, died in that city on January 14, after a short illness brought on by an attack of acute indigestion.

Alden R. Ludlow, formerly vice-president of the Liquid Carbonic Company of Chicago, has since January 1, 1919, been acting as second vice-president and sales manager of the Air Reduction Company, Inc., New York.

Kenneth C. Gardner has been appointed assistant manager of sales for the Central district of the Pressed Steel Car Company, with headquarters at Pittsburgh, Pa., succeeding Henry P. Hoffstot, who has resigned to become president of the Koppel Industrial Car & Equipment Company.

Joseph B. Weaver, vice-president and general manager of the Harlan & Hollingsworth Corporation, Wilmington, Del., has been appointed vice-president in charge of the manufacturing department of the Pullman Company with headquarters at Chicago.

A. A. Heller, treasurer and general manager of the International Oxygen Company, New York, has given up his active managerial duties, and Eugene Schoen has been appointed general manager for the company. Mr. Heller, as treasurer, continues in charge of the financial departments of the business.

Edward D. Hillman, secretary and engineer of the National Railway Appliance Company, New York, for the past two years, resigned from that company on January 1, and has accepted a position with the new Consolidated Steel Corporation, 165 Broadway, New York.

Captain George A. Post, Jr., of the Ordnance Department, U. S. A., has received an honorable discharge from the military service and has returned to the service of the Standard Coupler Company, as assistant to the president, with headquarters at 30 Church street, New York.

John C. Kuhns has left the service of the Oxweld Railroad Service Company to become identified with the Burden Iron Company, of Troy, N. Y., as manager of railroad sales. His headquarters will be at the Railway Exchange building, Chicago. Mr. Kuhns was formerly purchasing agent of the Illinois Central.

Automatic straight air brake equipment, developed by the Automatic Straight Air Brake Company, New York, is now being manufactured by the American Car & Foundry Company, for both passenger and freight cars. It is reported that within 60 days the installation of these brakes will begin on freight and passenger cars in regular service.

The Vanadium-Alloys Steel Company of Pittsburgh and Latrobe, Pa., maker of high-speed and alloy tool steels, has leased commodious offices and warerooms at 566-568 West Randolph street, Chicago, where will be carried a large stock of "Red Cut Superior" high-speed steel in all the standard sizes and shapes of bar stock, also treated bits for tool holders.

L. L. Body has been appointed manager of railway, street railway and marine sales of the Glidden Company, Cleveland, Ohio. Mr. Body has been identified with paint and varnish interests for many years. He began his career with the Sherwin-Williams Company in 1902, where he rose to the managership of railway and marine sales in 1912. In 1915 he severed his connection with Sherwin-Williams to become sales manager of the Master Builders' Company, Cleveland.

William T. Lane has been appointed district sales manager of the Franklin Railway Supply Company, Inc., with offices at San Francisco, Cal. Mr. Lane has spent his entire business career in the railway supply field. For the past seven years he has constantly been in touch with locomotive development. On leaving college he went as an apprentice with the Franklin Portable Crane & Hoist Company. His next position was as draftsman for the Franklin Railway Supply Company, Inc., and then chief draftsman. In 1915, he was made mechanical engineer of this company, which position he held at the time of his appointment as district sales manager, as noted above.

Wm. T. Lane

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is planning to erect several new buildings at Essington (South Philadelphia), Pa., to take care of turbine an delectric generator construction work that this now being handled at East Pittsburgh. It is planned to build at Essington all the large and important apparatus manufactured by the Westinghouse Company, and it is probable that in the future a building will be erected for the construction of electric locomotives, in which work the Westinghouse Company co-operates with the Baldwin Locomotive Works.

Lieutenant T. W. Jenkins, U. S. N. R. F., has been appointed manager of railway sales of the American Rolling Mill Company, Middletown, Ohio. Previous to the entry of the United States into the European war, Mr. Jenkins was in charge of sales of castings and forgings for this company. When the war broke out he was given indefinite leave to re-enter the navy, from which he had resigned in 1913. Lieutenant Jenkins served as an engineering officer on the navy transports throughout the war. Upon cessation of hostilities he was relieved from active duty to return to the commercial field.

W. C. Lincoln has been appointed engineer for the National Railway Appliance Company, New York. Mr. Lincoln was originally employed by the American Locomotive Company at Schenectady, leaving that company's service to enter Union University. After graduation and the completion of the General Electric Company's test course, he was assigned to special railway work by that company. Subsequently he took up and completed the engineering extension course, after which he was connected for some time with the consulting engineering department. Mr. Lincoln later entered the railway engineering department and in 1913 was transferred to the General Electric Company's Philadelphia district as

commercial engineer in the railway department, after which he entered the service of the Railway Improvement Company as electrical engineer.

W. C. L. Lamot, of Antwerp, advises that he is about to return to that city and would like to get in touch with any American firms who desire to establish an agency in Belgium. Mr. Lamot was established in Antwerp from 1907 until the outbreak of the war as an importer, exporter and shipping agent on his own account and had extensive business connections in both the industrial and commercial world. Since 1914 he has been acting as general merchant and commission agent in London, supplying many Belgian and British airplane, munition and engineering works. To facilitate matters he has given the *Railway Mechanical Engineer* a list of his connections as well as references. His present address is 22 Northumberland avenue, London, W. C. 2.

The Grip Nut Company, Chicago, has been reorganized with the following officers: Francis H. Hardy, chairman of the board of directors; William E. Sharp, president; Chester D. Tripp, vice-president; Herman A. Brassert, vice-president; Truman F. Miller, secretary and treasurer. The directors of the company include Messrs. Hardy, Sharp, Tripp, Brassert and Thomas G. Deering. William E. Sharp, who has been elected president of the reorganized corporation, began his railway career as an apprentice in the car department of the Erie in April, 1889. In October, 1892, he was promoted to general foreman of the car and locomotive department of the same road, with headquarters at Chicago. He left the Erie in 1898 to become assistant superintendent of the Armour Car Lines. In April, 1901, he was promoted to superintendent of those lines. He resigned that position in 1911 to enter the railroad supply business as vice-president of the Grip Nut Company. He was elected president in September, 1916, and became president of the reorganized corporation in November, 1918.

W. E. Sharp

The Electro-Dynamic Company, of Bayonne, N. J., which formerly manufactured the electric car lighting equipment for the Consolidated Railway Electric Lighting & Equipment Company, New York, has bought the entire stock in trade, assets, good will, etc., of the latter company, and will continue to manufacture and sell the "Axle Light" equipment formerly sold by the Consolidated, together with all repair parts for the Consolidated equipment now in service on the railroads. The Electro-Dynamic Company is controlled by the Submarine Boat Corporation and is known in the railway field as the manufacturer of the Edco interpole motors for railway shop use, machine tools and submarines. A separate department of the Electro-Dynamic Company has been created, known as the axle light department, to handle this work. There will be no interruption of the former Consolidated business.

Charles H. Wilson, who has been in active military service in France as a lieutenant of engineers, has been honorably discharged from the army and has resumed his duties as representative of Fairbanks, Morse & Co., Chicago. He was one of the survivors of the U. S. SS. "Lincoln," which was sunk by a German submarine 400 miles off Brest, France, while on a return trip to the United States. During his service with the American Expeditionary Forces Lieutenant Wilson, who was a reserve officer prior to the entry of this country in the world war, was attached to the British tank corps as mechanical officer and was later with the U. S. tank corps. On his return he was assigned for duty in the organization of tank corps units here, afterwards being on duty with engineer replacement troops. Prior to his entry into military service Mr. Wilson was located in Houston, Texas, as southwestern representative for Fairbanks, Morse & Co., with which company he has been associated for 14 years. He will now make his headquarters at St. Louis.

The Consolidated Steel Corporation, formed recently to handle the export trade of several independent steel producers, has opened offices in the City Investing building at 165 Broadway, New York. E. A. S. Clarke, former head of the Lackawanna Steel Company, is president of the export concern. The other officers are H. H. Barbour, vice-president, formerly of the Lackawanna Steel Company; W. Hesselman, secretary and controller, and A. Van Winkle, treasurer. Mr. Hesselman was controller of the Lackawanna company, and Mr. Van Winkle was secretary to Mr. Clarke when he was at the head of that concern. The traffic manager is William Heyman, formerly foreign freight agent for the Delaware, Lackawanna & Western Railroad. The independent steel companies represented in the organization are the Bethlehem Steel Corporation, the Brier Hill Steel Company, the Lackawanna Steel Company, the Lukens Steel Company, the Midvale Steel & Ordnance Company, the Republic Iron & Steel Company, the Sharon Steel Hoop Company, the Trumbull Steel Company, the Whitaker-Glessner Company and the Youngstown Sheet & Tube Company. The board of directors of the new export company is made up from the executives of these companies.

Nathaniel M. Rice has been elected a vice-president of the Pierce Oil Corporation, in charge of lubrication, with headquarters at 420 Olive street, St. Louis, Mo. The managers of the railroad lubricating, stationary engine lubricating and automobile lubricating departments will report to and receive instructions from Mr. Rice. Mr. Rice was formerly connected with the St. Louis - San Francisco, having occupied the position of purchasing agent, and later that of third vice-president. He was born December 28, 1863, at Rome City, Ind., received his early education in the public schools at that place, and in May, 1887, entered railway service as a brakeman on the Gulf, Colorado & Santa Fe. He served in various capacities in the transportation and store departments, and on April 1, 1901, he was made assistant general storekeeper of the Atchison, Topeka & Santa Fe Coast Lines, which connection he held until April 1, 1903, when he became general storekeeper in full charge of material, fuel and stationery, serving the entire system. In November, 1913, he was appointed chief purchasing agent of the St. Louis-San Francisco, with headquarters at St. Louis, Mo., and in September, 1916, was elected third vice-president of that road.

N. M. Rice

CATALOGUES

BOILER TUBE CLEANERS.—A general catalogue, X-4, has been issued by the Lagonda Manufacturing Company, Springfield, Ohio, describing in detail the boiler tube cleaners and accessories and other boiler room appliances manufactured by this company, and stating the work for which each type of cleaner is best adapted. All are illustrated and a number of sectional views are shown with the parts named.

TOOL HOLDERS.—Tool holders manufactured by the Gisholt Machine Company, Madison, Wis., for use in turret and engine lathes equipped with turret tool posts, are illustrated and described in a six-page folder issued by that company. Complete dimensions, sizes and prices are given. These holders were designed to make possible the use of worn down tools to the last inch or so, a fact which is of importance with the prevailing price of tool steel.

GRAPHITE PRODUCTS.—The United States Graphite Company, Saginaw, Mich., has published general catalogue No. 20, which gives detailed information about the line of lubricating graphite, greases, paints, etc., manufactured by this company. It also includes the report of tests made by the chief engineer of the Interborough Rapid Transit Company of New York, to determine the efficiency of graphite under actual operating conditions, and a number of microphotographs and curves.

ELECTRIC INDUSTRIAL TRUCKS.—Three types of electric industrial trucks designed for different services, including a carrying truck, an elevating platform truck and a tractor, manufactured by the Buda Company, Chicago, are described in its bulletins, 327, 328 and 329, respectively. These give a general description of the construction and specifications for each type, as well as illustrations and drawings. Bulletin 326 contains a brief description of the mechanical features common to all three types.

MALLET ARTICULATED LOCOMOTIVES.—Record No. 91, published by the Baldwin Locomotive Works, Philadelphia, Pa., is devoted to a non-technical description of Mallet articulated locomotives, illustrated with two sectional drawings. Instructions are given for the proper handling of these locomotives, as well as formulas for calculating their tractive effort. The booklet also contains a number of illustrations of various locomotives of this type, both for foreign and domestic roads, with their dimensions and general data.

RUST PREVENTIVES.—The Dearborn Chemical Company, Chicago, has issued a booklet entitled "The Prevention of Rusting or Corrosion of Iron and Steel," for the purpose of presenting evidence of the success that has followed the use of No-Ox-Id, a rust preventive developed by the Dearborn Chemical Company, as well as to describe other Dearborn products, including Dearboline, a preparation for cleaning machined parts of emery or grease, Klean-Kleen, for use in cleaning metal during various stages of manufacture, and cutting, quenching and drawing oils, etc.

IRON AND STEEL PRODUCTS.—A new edition of the Interstate Blue Book has been published by the Interstate Iron & Steel Company, Chicago. This book contains 204 pages and gives complete information regarding all Interstate products. Bars, bands, angles, channels, tees, flats and special shapes are shown with sizes listed for both wrought iron and high or low carbon steel, and the many other products of the company, including wire and wire products, staples and rivets are fully illustrated and described. The book contains the National Iron and Standard Steel classifications of price extras, as well as a number of weights and gages and other valuable information conveniently arranged for ready reference. The alloy and special analysis steels from the South Chicago plant are also described.

TURRET LATHES.—The Gisholt Machine Company, Madison, Wis., has issued a 102-page, 7¾-in. by 9½-in. catalogue, TLC-1, describing Gisholt turret lathes. It was the purpose in preparing this catalogue to show particularly what kinds of work these lathes will do. It contains over 100 illustrations, including a number of close-up views of the lathes actually at work, followed by 22 pages of line drawings showing parts which are successfully finished on Gisholt lathes; the time for finishing these parts is given under each drawing. A general description of the machine is also given, together with specifications and dimensions, and the last part of the book is devoted to standard tools for the lathes, boring bars, reamers, tool holders and chucks. The turret on carriage and gap lathes, as well as the motor driven lathes, are illustrated and described.

WESTINGHOUSE INSTRUMENTS AND RELAYS.—The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has issued a revised edition of catalogue 3-B, listing and describing Westinghouse switchboard, portable and precision instruments, ammeter shunts, transformers and relays. The catalogue contains 104 pages, 8½ in. by 12 in. and gives complete information about each instrument, describing the principle of operation and construction, as well as the work to which the instruments are especially adapted. Wherever possible each particular type of apparatus is listed on only one page and where more than one page is required, the several pages are confined to a description and listing of only one particular type, so that it is not difficult to find desired information. Several new types of apparatus are listed for the first time in this edition.

TOOL STEELS.—The Carnegie Steel Company, Pittsburgh, Pa., is now offering to the trade a new line of electric carbon tool steels made in five grades, containing different proportions of carbon, which are intended for utilization in the manufacture of tools where heretofore alloy steels have been used. A catalogue has been issued describing these steels and presenting practical information for the steel user, without going into an extended discussion of the theories of heat treatment. It contains a chart in colors of heat and temper colors which is a direct reproduction by color photography from test pieces heat treated to the temperatures shown. It affords a direct comparison by the blacksmith in the shop whereby it is possible to eliminate the effect of different lighting conditions. Pages devoted to reproduction of labels of the five grades also specify the various uses for each different grade of steel, and permit the selection of the proper grade for any particular use.

"UNDER FRAME" CAR LIGHTING EQUIPMENT.—The Safety Car Heating & Lighting Company, 2 Rector street, New York, has issued a 28-page book as a reference for the man who operates "under-frame" equipment. It is called Operation of Safety "Under-Frame" Car Lighting Equipment. The object of the book is to state briefly and concisely the essential points regarding the installation and operation of "under-frame" dynamos and type F regulators. The first part is given over to such subjects as installation of dynamo and suspension, lining up dynamo, belt lengths, measuring of belt lengths, application of belt fasteners, care of underframe suspension, operation of Safety type F dynamo regulator, method of adjusting automatic switch with car in yards, etc. The latter part of the book is given over to assembly and detail drawings and each detail part is numbered and named. The book is complete and well worth the attention of any one interested in car lighting equipment.